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A CONTINUING BIBLIOGRAPHY  
WITH INDEXES

JANUARY 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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# ENERGY

## A Continuing Bibliography

### With Indexes

### Issue 12

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from October 1 through December 31, 1976 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



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JANUARY 1977

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# INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(12)) lists 584 reports, journal articles, and other documents announced between October 1, 1976 and December 31, 1976 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included. The indexes are of the cumulating type throughout the year, with the fourth quarterly publication containing abstracts for the fourth quarter and index references for the four quarterly publications.

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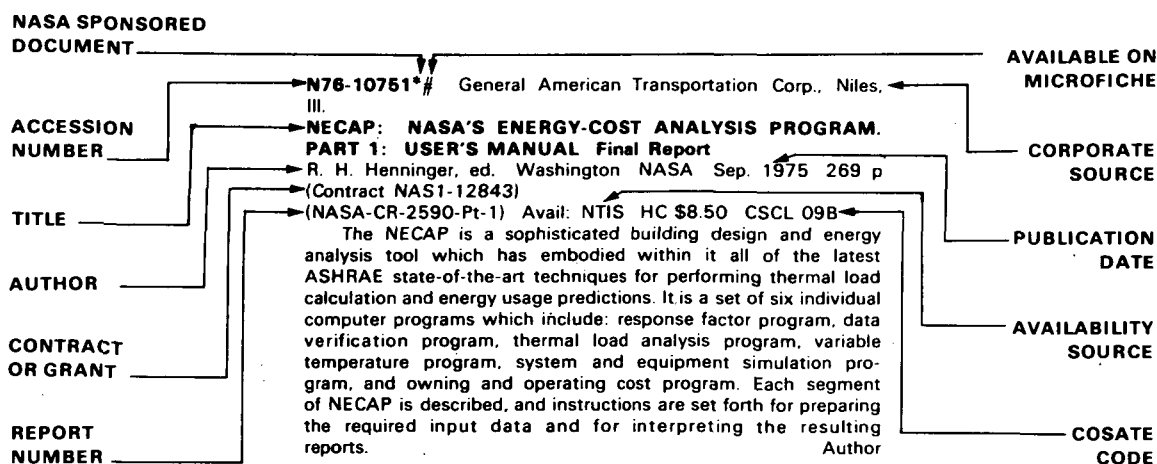
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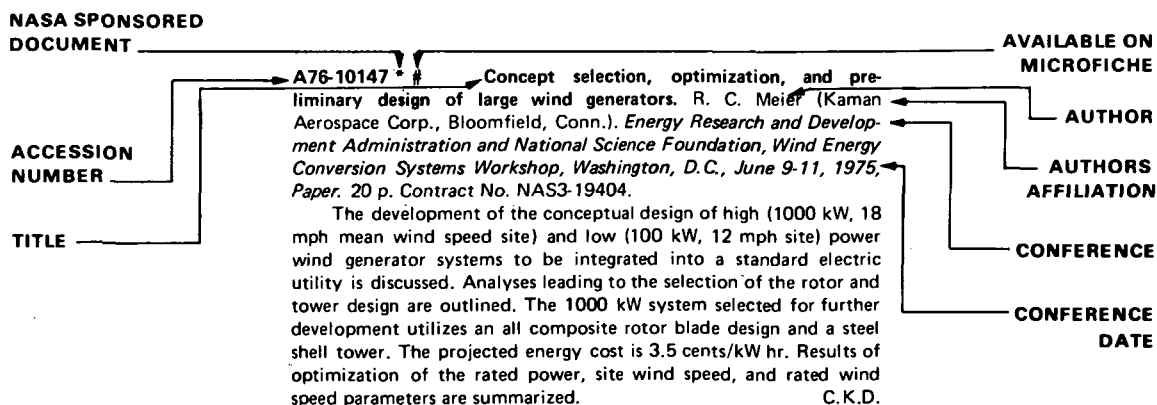
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## TYPICAL CITATION AND ABSTRACT FROM STAR



## TYPICAL CITATION AND ABSTRACT FROM IAA



## **A Listing of Energy Bibliographies Contained In This Publication:**

1. Hydrogen energy bibliography

p0209 A76-43029

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### IAA ENTRIES

**A76-38301** Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975. Conference sponsored by the European Physical Society. Geneva, European Physical Society, 1976. 429 p. \$30.

The work includes contributions on energy technology, elementary particle physics, astrophysics and nuclear physics. Papers are presented on the photochemical aspects of solar energy conversion, the photovoltaic effect, the state of controlled-fusion research, superconducting power transmission and superconducting energy storage. Materials for energy storage, the transport and storage of energy and energy research strategies are also considered.

B.J.

**A76-38302** Photochemical aspects of solar energy conversion. M. D. Archer (Royal Institution, London, England). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975. Geneva, European Physical Society, 1976, p. 41-64. 58 refs.

Some general considerations on solar photochemical energy conversion are presented, with consideration of factors that limit energy conversion efficiency: the threshold wavelength and spectral absorbance of the converter and the chemical free energy stored by the overall reaction. The occurrence of back reactions is examined and factors that limit the efficiency of photovoltaic and photoelectrochemical converters are discussed. Recent developments in photochemical energy conversion, the decomposition of water and the reductive fixation of carbon dioxide are treated, as are recent developments in photoelectrochemical energy conversion. Recent studies on photosynthesis are examined.

B.J.

**A76-38303** The maturity and future of nuclear energy. A. M. Weinberg (Oak Ridge Associated Universities, Oak Ridge, Tenn.). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975.

Geneva, European Physical Society, 1976, p. 79-89. 18 refs.

The original aims of nuclear development - compactness, conservation of uranium and cheapness - are discussed. New issues in nuclear energy are touched upon, with emphasis on reactor safety. Predictions are made about nuclear energy development during the next thirty years. The ability of mankind to overcome fear of nuclear technology is considered.

B.J.

**A76-38304** Transport and storage of energy. C. Marchetti (International Institute for Applied Systems Analysis, Laxenburg, Austria). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975.

Geneva, European Physical Society, 1976, p. 91-114.

The transportation, storage and general characteristics of various energy systems are discussed. Historical trends of energy storage and

transportation systems are considered. Technological forecasts, with detailed predictive charts, of future energy development are given. Attention is paid to the concept of negentropy.

B.J.

**A76-38306** Energy, gravitation and cosmology. A. Trautman (Warszawa, Uniwersytet, Warsaw, Poland). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975. Geneva, European Physical Society, 1976, p. 133-141. 35 refs.

An elementary article is presented on the relationship between energy and gravitation with particular reference to cosmology. Both Newtonian and relativistic theories of gravitation are considered.

B.J.

**A76-38308** Energy strategies. W. Hafele and W. Sassin (International Institute for Applied Systems Analysis, Laxenburg, Austria). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975.

Geneva, European Physical Society, 1976, p. 149-172. 18 refs.

The amount of fossil energy reserves and resources suggests a transition to our energy supply system that is based on a quasi-infinite fuel supply. Several options exist for this transition such as the nuclear breeder or solar power. Strategies for transitions have to meet a certain demand for energy. A simple but global scenario is given for such energy demand with emphasis on low demand in conjunction with fossil fuels. Consideration is given to the constraints of such fossil energy production and emphasis is put on the CO<sub>2</sub> problem. This allows a rough understanding of the time scale of such transitions. In view of the timing of the transition the various options for quasi-infinite supplies of energy are considered and priorities of a number of physics tasks are conceived.

(Author)

**A76-38314** Transport and storage of energy in secondary energy systems. Y. A. Rocher (Compagnie Générale d'Electricité, Marcoussis, Essonne, France). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975. Geneva, European Physical Society, 1976, p. 345-348.

The paper deals with transportation and storage of three forms of energy: electricity, heat, and synthetic fuels. The development of compressed gas insulation cables and superconducting cables for underground power transmission is considered along with different techniques for electric energy storage, including compressed air and thermal and electrochemical storage. The feasibility of producing synthetic fuels as secondary energy carriers using available or future primary energy sources, such as coal or organic wastes or nuclear or solar heat is examined.

B.J.

**A76-38315** Thermal energy storage. J. Schröder (Philips Forschungslaboratorium Aachen GmbH, Aachen, West Germany). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975.

Geneva, European Physical Society, 1976, p. 349-360.

10 refs.

Criteria are presented for the selection of thermal energy storage media, with heat capacity the chief of these criteria. A comparison is made of the specific heat capacities per unit volume of selected



compounds and conventional storage media, along with a comparison of the heats of fusion per unit volume in relation to the melting points of salt hydrates, water and other inorganic compounds and fluoride eutectics. Low grade heat and high temperature heat storage systems are considered with emphasis on a hydrate storage system. Various storage systems are compared from the points of view of capacity and cost effectiveness. B.J.

**A76-38316** Solar energy utilization in photosynthesis. G. Forti (Milano, Università, Milan, Italy). In: Energy and physics; Proceedings of the Third General Conference, Bucharest, Rumania, September 9-12, 1975. Geneva, European Physical Society, 1976, p. 375-378.

The process of photosynthesis in plants is described in detail with particular attention paid to energy balance. The possible development of a solar energy conversion technology using photosynthesis is discussed with reference to the following three areas: (1) hydrogen production in certain microalgae, (2) the use of photosynthesis in constructing photovoltaic cells, and (3) the use of photosynthetic microorganisms for the treatment of sewage water and other wastes for the purposes of water purification and biomass production. B.J.

**A76-38473** Solar cells. Edited by C. E. Backus (Arizona State University, Tempe, Ariz.). New York, IEEE Press, 1976. 511 p. \$12.45.

The present volume constitutes a reference book containing classic papers in the field of solar cells as well as a relatively complete photovoltaic bibliography. The general subjects include the historical development of solar cells, solar-cell theory, cell fabrication, space systems, terrestrial applications, and working-group resumes and discussions. Individual papers deal with such topics as silicon p-n junction photocells, effects of temperature on photovoltaic solar-energy conversion, series resistance effects on solar-cell measurements, drift fields in photovoltaic solar-energy-converter cells, the violet cell, the photovoltaic effect in CdS, efficiency calculations of heterojunction solar-energy converters, CdTe solar cells and photovoltaic heterojunctions in II-VI compounds, the photovoltaic effect in GaAs p-n junctions, and the multiple-junction edge-illuminated solar cell. Other papers discuss silicon solar cell degradation in the space environment, direct solar-energy conversion for terrestrial use, single-crystal and polycrystalline silicon, and CdS/Cu<sub>2</sub>S thin-film cells. F.G.M.

**A76-38551** Energy analysis of wave-power and wind-power systems. P. J. Musgrove (Reading, University, Reading, Berks., England). *Nature*, vol. 262, July 15, 1976, p. 206, 207. 10 refs.

The energy investment required for the construction of rocking float wave-power systems is compared with the predicted energy return. An energy recovery period of about 16 years is predicted for a 50-m rocking float, assuming an overall efficiency of 50% for a system operating where the annual average power in the waves is 77 kW/m. Estimated energy recovery periods for wind-power systems are as low as a few months. Wind systems are shown to offer a power density comparable with that assumed for wave-power systems. C.K.D.

**A76-38674** Perturbation analysis of quasi-static behavior of brush-type super flywheels. C. W. Bert (Oklahoma, University, Norman, Okla.). *Mechanics Research Communications*, vol. 3, no. 4, 1976, p. 237-243. 15 refs.

The purpose of this paper is to present an improved analysis of the quasi-static behavior of a typical radial filament in a brush-type super flywheel. The material is assumed to be perfectly elastic with a finite Poisson's ratio. It is shown that the rotational speed at which tensile instability resulting in filament necking occurs can be considerably lower than that predicted by previous analyses reported in the literature. Numerical results are presented in dimensionless form for ranges of parameters of current design interest. (Author)

**A76-38724** Feeding the glutton. S. H. Smiley, M. L. Ernst, G. Sege, and R. T. Jaske (U.S. Nuclear Regulatory Commission, Washington, D.C.). *IEEE Spectrum*, vol. 13, July 1976, p. 74-83.

The major conclusions of the Nuclear Energy Center Site Survey are discussed. An alternative siting approach for nuclear power and fuel-cycle facilities based on 'clustering' of such facilities on a relatively small number of sites, in contrast with current 'dispersed' siting practices, was evaluated. Three types of nuclear energy centers were included: power centers, consisting of 10-40 electric generating units of 1200-MW electric capacity each; fuel-cycle centers, consisting of fuel-reprocessing plants, mixed-oxide fuel-fabrication facilities, and radioactive waste management facilities; and combined centers, containing both generating units and fuel-cycle facilities. Among major technical feasibility issues considered were the dissipation of waste heat from the energy center; the design, reliability, and economics of transmission systems; the economics of energy center construction; and environmental impact. The findings support the conclusion that, although it can be feasible and practical to construct up to 20 nuclear power reactors on a single site, there is no compelling reason to do so. Similar conclusions were reached with regard to fuel-cycle centers. C.K.D.

**A76-38799** Optical frequency conversion in metal vapors. D. M. Bloom (Stanford University, Stanford, Calif.). In: Laser induced fusion and X-ray laser studies. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1976, p. 631-649. 23 refs.

Investigations related to third harmonic generation in alkali metal vapors are discussed and problems of phase-matching are considered. Experiments utilizing two different phase-matching techniques are reported. In the techniques for efficient third harmonic generation relatively efficient conversion efficiencies have been obtained. The techniques have required picosecond time scale lasers with peak powers in excess of 100 MW. G.R.

**A76-38857** # Analysis of saturated magnetic electromechanical converters on the basis of a generalized machine-model of magnetoelectric devices (Analiz elektromekhanicheskikh preobrazovatelei energii 'nasyshchennym' magnitoprovodom na baze obobshchennoi mashiny-modeli magnitoelektricheskikh ustroystv). I. V. Kyzina and P. M. Markin (Moskovskii Institut Elektronnogo Mashinostroeniia, Moscow, USSR). *Priboroostroenie*, vol. 49, no. 5, 1976, p. 53-58. 5 refs. In Russian.

**A76-38876** Prospects for the development of gas turbine installations in the USSR. P. O. Siry, V. L. Polishchuk, I. I. Kirillov, N. M. Markov, and Iu. G. Korsov (Ministerstvo Tiazhelogo Mashinostroeniia SSSR, Moscow; Leningradskii Politekhnikeskii Institut; Tsentral'nyi Nauchno-Issledovatel'skii Kottloturbinnii Institut, Leningrad, USSR). (*Teploenergetika*, vol. 22, no. 6, 1975, p. 2-4.) *Thermal Engineering*, vol. 22, June 1976, p. 1-5. 5 refs. Translation.

The paper examines the technical and economic feasibility of utilizing gas turbine installations in a number of applications: for driving pumps at compressor stations for gas mains; as emergency standby power plants; to drive generators in mobile power installations in remote areas; in different steam turbine arrangements and also power engineering arrangements designed to cover base and peak loads. The chief technical characteristics of gas turbine installations are enumerated and methods for increasing their efficiency are discussed. B.J.

**A76-38877** Operating results of GT-100-750-2 gas turbine installations in the Inota heat and power station in the Hungarian People's Republic. B. V. Aref'ev (Leningradskii Metallicheski Zavod, Leningrad, USSR). (*Teploenergetika*, vol. 22, no. 6, 1975, p. 4-6.) *Thermal Engineering*, vol. 22, June 1976, p. 6-9. Translation.

**A76-39022** **Solar heating at an observatory.** J. S. Hall and H. Wade (Lowell Observatory, Flagstaff, Ariz.). *Sky and Telescope*, vol. 52, Aug. 1976, p. 84, 85.

The experimental solar energy system used to heat the observer's quarters of Lowell Observatory on Anderson Mesa, Arizona, is described. The system incorporates two collectors with a total effective area of 170 sq ft, about 40% of the floor area to be heated. Black-painted corrugated iron is used in one collector; the other utilizes 1254 discarded aluminum soft-drink cans in 57 parallel arrays. Air from separate blower systems driven by a 1/3 horsepower motor is forced under the iron sheeting and between the open-end cans of the collectors. Energy from the heated air is stored in three tons of rocks. C.K.D.

**A76-39066 #** **Solar energy and its applications (L'energia solare e le sue applicazioni).** C. Calzolari (Osservatorio Astronomico, Bologna, Italy) and A. Dumas (Istituto di Fisica Tecnica, Bologna, Italy). *Società Astronomica Italiana, Memorie*, vol. 46, Nov. 1975, p. 371-395. 19 refs. In Italian.

The feasibility of using solar energy and various modes of utilization are reviewed. Solar energy is seen as a valid alternative in the quest for a new energy source. Italy's present 100 billion kWh/yr energy needs are satisfied 63 per cent by fossil-fuel power plants, 31 per cent by hydroelectric plants, and 6 per cent by nuclear reactors and exploitation of geothermal energy. Insolation calculations geometry, with atmosphere ignored or taken into account, and a chart of factors modifying insolation intensity are presented. Direct radiation, diffuse radiation, and global radiation are compared, and the discussion covers: sunlight absorbance, thermal emittance, the greenhouse effect and its applications, combined solar energy and conventional power plants, photoelectric cells and semiconducting solar cells, photochemical transformations, and thermoelectric cells. R.D.V.

**A76-39077** **Position of aluminum in various fields of application with regard to the energy situation.** D. P. Reynolds (Reynolds Metals Co., Richmond, Va.). In: International Conference on Light Metals, 6th, Leoben and Vienna, Austria, June 16-20, 1975, Proceedings. Düsseldorf, Aluminium-Verlag GmbH, 1975, p. 21-23.

Relations between the energy supply situation and the cost of aluminum are examined. Aluminum is competitive with other materials from the standpoint of energy costs. Its technological momentum and its recyclability give aluminum a significant advantage. An investigation is conducted concerning the impact of the energy situation on markets and applications for aluminum. Attention is given to the areas of transportation, building and construction, energy transmission, and packaging. G.R.

**A76-39098** **Status and future development of electric power in the Federal Republic of Germany with special regard to nuclear energy and the supplying of high power-consuming industries (Stand und Entwicklung der Stromversorgung in der Bundesrepublik Deutschland unter besonderer Berücksichtigung der Kernenergie und der Belieferung stromintensiver Industrien).** J. M. Vogel (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). In: International Conference on Light Metals, 6th, Leoben and Vienna, Austria, June 16-20, 1975, Proceedings. Düsseldorf, Aluminium-Verlag GmbH, 1975, p. 187-189. In German.

**A76-39271** **Today's energy sources - Their projected life.** J. J. McKetta (Texas, University, Austin, Tex.). *Energy Communications*, vol. 1, no. 1, 1975, p. 5-19.

It is pointed out that the U.S. cannot meet the energy demands through the year 2000 without yearly increasing the energy imported from overseas. The U.S. is currently importing over 44% of all the liquid hydrocarbons consumed. In the case of natural gas the available supplies will last the U.S. at most 35 years. The total

demand for all types of energy in the U.S. during the period from 1972 to 2000 is shown in a graph together with data regarding the supply of energy with respect to the various energy sources. It is shown that predictions regarding the U.S. energy source for 1985 made in 1974 are considerably lower than estimates for 1985 reported in 1970. Measures to alleviate the energy crisis are discussed. G.R.

**A76-39272** **SYNTHOIL process for converting coal to nonpolluting fuel oil.** S. Akhtar, N. J. Mazzocco, M. Weintraub, and P. M. Yavorsky (U.S. Bureau of Mines, Pittsburgh, Pa.). (*Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.*) *Energy Communications*, vol. 1, no. 1, 1975, p. 21-36. 7 refs.

In connection with the critical supply situation for the U.S. in the case of petroleum-derived fuel and the existence of comparatively abundant coal resources, it is recommended to increase the percentage of energy obtained from coal. A direct use of coal as fuel is, however, undesirable because of environmental considerations. Studies were, therefore, conducted to develop a suitable process for producing a clean, utility liquid fuel from coal. These studies led to the development of the SYNTHOIL process. In this process coal is liquefied and desulfurized in one step by catalytic hydrotreatment in a novel turbulent-flow, packed-bed reactor. G.R.

**A76-39273** **A time schedule for commercialization of coal liquefaction processes in the United States.** B. L. Crynes (Oklahoma State University, Stillwater, Okla.). *Energy Communications*, vol. 1, no. 1, 1975, p. 37-56. 7 refs.

The processes considered include solvent refining, pyrolysis, and direct hydrogenation of coal leading to liquids. A description is given of various technological procedures related to these processes. The time requirements needed to advance from the present level of activity to a first full-scale plant are examined. Attention is given to present activities and a forecast concerning the commercialization of coal liquids. It appears that the first commercial coal liquids plant will probably be produced in 1984 or 1985. G.R.

**A76-39274** **Development of a fluidized bed coal gasification process for electric power generation.** D. H. Archer, D. L. Keairns, and E. J. Vidt (Westinghouse Research Laboratories, Pittsburgh, Pa.). (*Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.*) *Energy Communications*, vol. 1, no. 2, 1975, p. 115-134. 10 refs.

A multistage fluidized bed coal gasification and particulate removal system is coupled with a combined cycle power plant. Coal is gasified using air and steam at 1600 to 2100 F and 15 to 20 atm pressures. Sulfur is removed using limestone or dolomite sorbent. Particulates are removed by a combination of cyclones and granular bed filters or rotary impaction filters. The coal gasification process development unit consists of devolatilizer/desulfurizer and combustor/gasifier units, internal refractory insulation and a carbon steel shell. The laboratory support program areas of investigation include fluidization and solids handling, coal behavior, sulfur removal system, particulate removal system, gas turbine system and systems studies. B.J.

**A76-39275** **The Kellogg Molten Salt Process.** A. E. Cover and W. C. Schreiner (Kellogg Co., Houston, Tex.). (*Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.*) *Energy Communications*, vol. 1, no. 2, 1975, p. 135-156.

The use of molten salt (sodium carbonate) to produce substitute natural gas from coal is discussed. The advantages of this molten salt coal gasification process are: (1) all types of coal including caking coals can be handled directly; (2) sodium carbonate catalyzes the gasification of the tar components, resulting in a maximum gas yield

and reduced pollution; (3) with the use of sodium carbonate, a lower gasification temperature is allowed for complete coal gasification; and (4) since the reactor is not a fixed-bed gasifier, independent control of residence time and temperature is permitted. The use of molten salt for the processing of such hydrocarbon fuels as heavy oil and municipal refuse for products such as gasoline, fuel oil, olefins, and ammonia is also considered. B.J.

**A76-39276 Economics of the K-T process.** D. M. Mitsak, J. F. Farnsworth, and R. Wintrell (Koppers Co., Inc., Pittsburgh, Pa.). (*Symposium on Coal Gasification and Liquefaction Best Prospects for Commercialization, University of Pittsburgh, Pittsburgh, Pa., Aug. 6-8, 1974.*) *Energy Communications*, vol. 1, no. 2, 1975, p. 157-178.

The average gas cost of intermediate and high Btu gas produced in the Koppers-Totzek coal gasification process (for the production of a clean gaseous fuel and synthesis products such as hydrogen, ammonia, and methanol) was calculated. The coal preparation and gasification process is described, along with the processes of gas cooling and cleaning and sulfur removal. Costs associated with the K-T process are discussed, including capital costs of 300 Btu gas plants, the selling price of 300 Btu gas, and the costs of chemical products. B.J.

**A76-39277 Will coal ride to the rescue.** H. Foster (National Coal Association, Washington, D.C.). (*Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.*) *Energy Communications*, vol. 1, no. 3, 1975, p. 221-240.

The effect of proposed legislation regarding the relaxation of environmental standards to permit the direct utilization of high-sulfur coals on the ability of the coal industry to meet future energy needs is discussed. The impact of proposed restrictions on strip mining is examined. It is argued that environmental concerns should be temporarily assigned a lower priority than the development of the nation's energy self-sufficiency based on more extensive use of coal resources. C.K.D.

**A76-39278 Rational criteria for energy utilisation and source assessment.** I. Kavrak (Bogazici Universitesi, Istanbul, Turkey). *Energy Communications*, vol. 1, no. 3, 1975, p. 241-250.

Two criteria are suggested for assessing the effectiveness of a given energy use thermodynamically and economically. The first - Energy Utilization Efficiency (EUE) - is derived by considering the economy as an energy converter; the output is the sum of the actual useful work of services and the net energy consumption of manufactured goods, while the input is the sum of raw energy supplied from all sources. The EUE is defined as the ratio of the output to the input, and is calculated using a First Law of Thermodynamics analysis, taking into account losses accompanying conversions of raw energy into available energy, transportation of energy, and conversion of available energy into utilized energy. The calculation of the second criterion, Cost of Utilized Energy, is analogous to that of the EUE, substituting the cost of each raw energy source for amount of raw energy. C.K.D.

**A76-39279 Clean environment with K-T process.** J. F. Farnsworth, D. M. Mitsak, and J. F. Kamody (Koppers Co., Inc., Pittsburgh, Pa.). *Energy Communications*, vol. 1, no. 3, 1975, p. 251-287.

The Koppers-Totzek process for the gasification of solid or liquid fuels is described, with special attention given to its application to coal. Product analyses are presented for western coal, eastern coal, and green petroleum coke. The feed coal is dried to 2-8% moisture and pulverized to about 70%. The pulverized coal is discharged into a mixing nozzle where it is combined with oxygen and low temperature steam. The oxygen, steam and coal react in the gasifier at a slight positive pressure and at 3300 F. The carbon and

volatile fraction of the coal are gasified. Liquid slag and particulates are removed by direct water quenching, passage through a venturi scrubbing system, and treatment with electrostatic precipitators. The choice between a variety of processes available for the removal of sulfur is made on the basis of the pressure and end uses of the gas. The process is capable of producing 300 Btu/cu ft synthesis gas; a heating value of 960 Btu can be obtained by catalytic upgrading. The environmental controls responsible for the pollution-free character of the process are described in detail. C.K.D.

**A76-39280 Commercial coal liquefaction is needed before 1980.** R. T. Ellington (Fluor Engineers and Constructors, Inc., Houston, Tex.). (*Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.*) *Energy Communications*, vol. 1, no. 3, 1975, p. 289-308. 8 refs.

The future development of a large coal liquefaction industry is discussed. An analysis of cost-time relationships for different stages of the planning and implementation of plants with outputs of at least 250 Btu per day is presented. The state of the art of coal liquefaction is reviewed, with consideration given to the current status of major low-temperature pyrolysis and dissolution type processes. It is concluded that the technology base for commercial design is sufficient to place the first liquefaction plants on stream by 1980, assuming time compression and overlapping of future testing is carried out to allow immediate initiation of projects. C.K.D.

**A76-39281 Progress in coal liquefaction.** M. C. Sooter (Catalytic, Inc., Philadelphia, Pa.). (*Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.*) *Energy Communications*, vol. 1, no. 3, 1975, p. 309-317. 6 refs.

The history of solvent refined coal liquefaction processes is reviewed, and the PAMCO process being piloted at Wilsonville, Ala. is discussed. This coal liquefaction process slurries the coal with a solvent, dissolves the coal in a reactor, removes the solid residue, recovers the solvent for recycle to slurry, and solidifies the clean extracted coal. Hydrogen consumption for the process is low. The pilot plant, designed to process 6 tons per day, has been successfully demonstrated in a 45-day run using a composite of western Kentucky 9 and 14 coal containing about 3 wt % sulfur. Technical data and product characteristics for the pilot project are presented. C.K.D.

**A76-39282 Energy conservation - Back to basic engineering.** F. H. Ramseur, Jr. (Cities Service Oil Co., Tulsa, Okla.). *Energy Communications*, vol. 1, no. 3, 1975, p. 319-328.

Engineering involvement in the development, organization, and maintenance of an energy conservation program for industrial operations is discussed. The efforts of the engineering staff may be effectively channeled in two directions. Together with the operations and maintenance group for a given plant, the engineering staff should pursue the identification, evaluation, and implementation of energy optimization opportunities in routine operations and direct maintenance programs required for energy optimization. Key indicators of energy efficiency should be developed to characterize a given process or piece of equipment. In addition, the Process Engineering Group should define potential energy optimization opportunities requiring physical revision and capital expenditure and identify areas in which there is a need for basic changes in operating philosophy and standards. The engineering staff should be further responsible for the continuous evaluation and balancing of available fuels and costs, and for anticipating future energy developments and their associated technological requirements. C.K.D.

**A76-39283 U.S. energy planning in an interdependent world.** M. J. Deutch (Commission on Critical Choices for Americans, New York, N.Y.). *Energy Communications*, vol. 1, no. 4, 1975, p. 335-343.

The paper reviews causes of the world-wide energy shortage, and various options for remedial action, including the need for new facilities, the role of new technology, and new institutional arrangements for more flexible and balanced environmental and conservation strategies. The international interface of U.S. energy policy is examined, and the areas of possible conflict over supplies and price are identified. The need for international cooperation in energy problem-solving to reduce excessive lead-times and costly duplication of R & D, and to improve economic stability in an interdependent world is stressed. The role of the cross-disciplinary policy planner in determining feasibility and cost of advanced research and development, and better efficiency in fuel substitution, is described.

(Author)

**A76-39284** Energy in the service of society. P. J. Grogan (Wisconsin, University, Madison, Wis.). *Energy Communications*, vol. 1, no. 4, 1975, p. 345-376.

A layman's approach is used to examine the evolution of the role of energy in human society. Attention is given to the transition from wood to coal to oil and gas economies. Factors contributing to the exponential increase in the rate of consumption of natural energy resources are considered. The cost of 1 MBtu of energy in different forms is given, together with examples of the work that can be obtained by its use. The current estimates of available reserves of petroleum, coal, and natural gas are discussed, and the development of alternative technologies for energy production is examined. Possible changes in the organization of society and in its system of values and priorities that may be necessitated by the shortage of energy are described. C.K.D.

**A76-39285** Production needs for hydrotreating catalysts for commercialization of coal liquefaction processes. B. L. Crynes (Oklahoma State University, Stillwater, Okla.). *Energy Communications*, vol. 1, no. 4, 1975, p. 377-401. 22 refs.

The production needs for hydrotreating catalysts used in coal liquefaction processes are predicted on the basis of two separate estimates of the rate of implementation of commercial coal liquefaction. One, assuming a slow build-up rate, predicts a total coal liquids production of 1.3 million barrels per day by the year 2000; the other predicts a production of 2.2 million barrels per day. The basic hydrotreating catalyst requirements of the solvent refined coal, clean synthetic fuel, COED, and H-coal processes are assessed and compared. Results are compared with those obtained in a similar analysis of petroleum processes. Supply-demand relationships for common hydrotreating catalyst materials, such as cobalt, nickel, alumina, molybdenum, tungsten, and silica, are examined. C.K.D.

**A76-39286** The production of gas from coal through a commercially proven process. J. F. Farnsworth, H. F. Leonard, D. M. Mitsak, and R. Wintrell (Koppers Co., Inc., Pittsburgh, Pa.). (Oklahoma State University, Conference on Synthetic Fuels from Coal, 4th, Oklahoma State University, Stillwater, Okla., May 6, 7, 1974.) *Energy Communications*, vol. 1, no. 4, 1975, p. 403-423.

The production of gas from coal using the Koppers-Totzek process is discussed. The process is based on the partial oxidation of pulverized coal in suspension with oxygen and steam. There are no tars, condensable hydrocarbons or phenols formed; carbon conversion is dependent on the reactivity of the coal, approaching 100% for lignites. Depending on the treatment of the raw gas, low Btu fuel gas, synthesis gas, substitute natural gas, or hydrogen- and carbon-monoxide-rich gases can be produced. Typical process data for western sub-bituminous, Illinois high-volatile B bituminous and eastern high-volatile A bituminous coals are presented. For the coals considered, the process efficiency is in the 85-90% range. The capital cost of a grass-roots plant producing 250 million cubic feet per day of pipeline gas is about 350 million. C.K.D.

**A76-39287** Coal gasification for industrial fuel. E. J. Ferretti, K. C. Baczewski, and A. C. Mengon (Dravo Corp., Pittsburgh, Pa.). *Energy Communications*, vol. 1, no. 5, 1975, p. 433-494.

A description is presented of the characteristics of the various gaseous fuels which can be manufactured from coal, taking into account certain hazards involved in the presence of high concentrations of carbon monoxide. The process technology for manufacturing the gases is reviewed. The various types of gas producers that are available or under development are discussed, giving attention to the Lurgi process, the Riley-Morgan gasifier, the Wellman-Galusha gasifier, the Wilputte producer, the U.S. Bureau of Mines gasifier, the acceptor process, the Synthane process, and the Koppers-Totzek process. Questions of economics are also considered. G.R.

**A76-39288** Synthetic gas and liquid fuels from coal. M. R. Tek (Michigan, University, Ann Arbor, Mich.). *Energy Communications*, vol. 1, no. 5, 1975, p. 495-523. 7 refs.

The significance of coal conversion in relation to other energy technologies is examined, taking into account tar sands and shale oil recovery, energy from solid wastes, solar heating and cooling, the fast breeder-reactor, and geothermal power. The nature of coal is briefly reviewed and the available coal reserves are considered. Attention is given to the desulfurization of coal, the various steps leading from the mining of coal to its end-use, and questions regarding the economics of solid and liquid fuels from coal. G.R.

**A76-39289** Whatever happened to reason - One man's view of hydrocarbon supplies. D. L. Rooke (Dow Chemical Co., Midland, Mich.). *Energy Communications*, vol. 1, no. 5, 1975, p. 525-538.

The approaches taken by an American chemical company in connection with development related to the available supply of hydrocarbons are examined, taking into account also the solution of U.S. energy and hydrocarbon raw material problems on a national basis. It is pointed out that the solution of these problems will probably be partly based on a utilization of coal, of which the U.S. has very large reserves. G.R.

**A76-39301** Laser 75 opto-electronics; Proceedings of the Conference, Munich, West Germany, June 24-27, 1975. Edited by W. Waidelich (Darmstadt, Technische Hochschule, Darmstadt, West Germany). Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1976. 293 p. \$39.30. In English and German.

The use of lasers in nuclear energy technology, in material processing (welding, metal cutting, etc.), in medicine, in optical communications systems, in data processing, in environmental monitoring, and in metrology and testing is considered. Also examined are opto-electronic components (solar cells and photodiodes), television systems, opto-electronic displays (electrochromic, electrophoretic, and plasma displays) and infrared and ultraviolet techniques (infrared radiometry of the atmosphere, thermal imagery; semiconductor detectors of UV radiation, etc.).

B.J.

**A76-39302** Solar cells (Solarzellen). H. Fischer (Telefunken AG, Heilbronn, West Germany). In: Laser 75 opto-electronics; Proceedings of the Conference, Munich, West Germany, June 24-27, 1975. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1976, p. 1-8. 18 refs. In German.

The physical properties of ideal and real solar cells are discussed with emphasis on volt-ampere characteristics and a discussion of the theoretical aspects of photovoltaic energy conversion. Techniques for increasing solar cell output are considered along with methods for optimizing their energy conversion efficiency. The use of Cu<sub>2</sub>S-CdS thin film cells and GaAs cells is examined along with that of the conventional silicon cells. Terrestrial applications of solar cells for power production are considered. B.J.

**A76-39351 # Urban utilization of waste energy from thermal-electric power plants.** A. Ileri, G. M. Reistad, and W. E. Schmisser (Oregon State University, Corvallis, Ore.). (*American Society of Mechanical Engineers and Institute of Electrical and Electronics Engineers, Joint Power Generation Conference, Portland, Ore., Sept. 28-Oct. 1, 1975, ASME Paper 75-Pwr-12.*) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol. 98, July 1976, p. 309-319. 7 refs. Research supported by the Portland General Electric Co., Pacific Power and Light Co., and Boeing Co.

Results are reported for a study of urban utilization of thermal waste energy from steam-electric power plants. In the study, a steam bleed-off system and a heat-pump system were evaluated for supplying the thermal energy requirements of space heating, air conditioning, and domestic water heating for urban communities in three climatologically different locations and ranging in population from 30,000 to 200,000. The system performances are evaluated for light-water reactors, liquid-metal fast-breeder reactors, advanced nuclear reactors, and fossil-fuel plants. The results show that both systems are quite close to each other in performance and offer tremendous energy savings relative to a system with electrical-resistance heating and electrically driven air conditioning units. The thermal pollution associated with each system is determined. F.G.M.

**A76-39353 # Corrosion and deposits from combustion of solid waste. IV - Combined firing of refuse and coal.** H. H. Krause, D. A. Vaughan, and W. K. Boyd (Battelle Columbus Laboratories, Columbus, Ohio). (*American Society of Mechanical Engineers, Winter Annual Meeting, Houston, Tex., Nov. 30-Dec. 5, 1975, Paper 75-WA/CD-4.*) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol. 98, July 1976, p. 369-374. 9 refs. U.S. Environmental Protection Agency Grant No. R-804008-01-0.

Combined firing of processed municipal refuse with coal has been investigated in a stoker-fired boiler. The refuse preparation consisted of shredding, magnetic separation of metals, and air classification. The nature of the deposits and the extent of corrosion of simulated boiler-tube surfaces was determined by inserting probes into the boiler. For amounts of refuse up to 35 per cent on a heating-value basis, the corrosion rate of carbon steels was reduced substantially, below that found from previous measurements for refuse alone, and below that calculated on the basis of dilution by the coal. The temperature of the boiler flue gases also was found to be an important factor in corrosion. The emissions of sulfur oxides from high-sulfur coal were reduced by the action of the alkaline components of the refuse. (Author)

**A76-39371 ERDA's fossil energy activities.** P. C. White (ERDA, Washington, D.C.). *Environmental Science and Technology*, vol. 10, Aug. 1976, p. 746-750.

The Fossil Energy Research Program under the auspices of the Energy Research and Development Administration (ERDA) is discussed. The Fossil Energy program seeks to develop and demonstrate, in conjunction with industry, the technology necessary for establishing a synthetic fuels-from-coal industry. In addition, improved methods for recovering petroleum, oil shale, and natural gas are under investigation. Projects utilizing second-generation technology for coal liquefaction, high-Btu gasification, and low-Btu gasification are described. C.K.D.

**A76-39476 Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record.** Conference sponsored by the Institute of Electrical and Electronics Engineers. Edited by E. Pierce. New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication, No. 76CH1062-9 REG 6), 1976. 222 p. \$20.

The Conference includes papers assessing possible future energy sources and examining state-of-the-art and future trends in a variety of areas concerned with energy production and use, including energy transmission, power technology, energy storage, electronic test equipment, applied electronics, and military satellite communications. Among the topics considered are trends in protective relaying,

hydroelectric pumped storage, a 100 MWe solar energy conversion power plant design, the advantages of time sharing in automatic testing, the application of microprocessors in protection systems for nuclear power generating stations, and modulation considerations for processing satellites.

C.K.D.

**A76-39477 The nuclear breeder.** J. B. Yasinsky (Westinghouse Electric Corp., Madison, Pa.). In: *Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record.* New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 5-8.

Three major Liquid Metal Fast Breeder Reactor (LMFBR) development projects are described: the Fast Flux Test Facility (FFTF), the Clinch River Breeder Reactor (CRBR), and the Prototype Large Breeder Reactor. The FFTF, scheduled for completion in August 1978, will provide capability for fuel testing up to and including the point of failure in four independent test loops of a 400 MWt system. The CRBR plant is in the engineering design stage prior to licensing. The 350 MWe, three loop sodium cooled plant is expected to demonstrate the safety, reliability and economic potential of the LMFBR in a utility environment. The mixed uranium-plutonium oxide fuel design is similar to fuel designs for larger future plants which will provide fuel doubling times of 12 to 15 years. A 30 month conceptual design program for the Prototype Large Breeder Reactor was initiated in 1975 with the objective of completing the conceptual design of an integrated commercial size plant, developing the basis for the needed safety and environmental reports, and completing a proposal for potential utility customers. Target date for construction of the prototype is 1988. C.K.D.

**A76-39478 Nuclear fusion.** R. L. Hirsch (ERDA, Washington, D.C.). In: *Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record.* New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 9-14.

The basic principles of power production from controlled fusion are presented, and the development of fusion research is reviewed. The three major magnetic confinement techniques - theta pinch, mirror machine, Tokamak - and laser-pellet fusion are described. Existing confinement experiments, including the 2X-11B at Lawrence Livermore Laboratory, the theta pinch program at Los Alamos Scientific Laboratory, the Adiabatic Toroidal Compressor at the Princeton Plasma Physics Laboratory, and the ORMAK at the Oak Ridge National Laboratory, are discussed. The major features of proposed confinement experiments and reactors (the Princeton Large Torus, the Tokamak Fusion Test Reactor, and the Doublet Fusion Reactor Concept) are outlined. C.K.D.

**A76-39479 The future of solar energy in the U.S.** G. G. Leeth (General Electric Co., Santa Barbara, Calif.). In: *Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record.* New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 15-18. 17 refs.

The present status of solar energy development is assessed, and the evolution of direct solar energy systems during the time period 1975-2000 is considered. The energy yield and costs of biomass conversion, photovoltaic, and high- (up to 4000 K) and low-temperature (320-340 K) systems are analyzed. It is concluded that direct solar energy will contribute a small fraction of the nation's total energy needs by the year 2000. It is predicted that heating and cooling of buildings will be the first major application of solar energy to come into widespread use. Thermal electric systems will appear next, followed by photovoltaic systems, which will require a major technical-cost breakthrough. Biomass conversion will be the least significant direct utilization of solar energy during the time period considered. C.K.D.

**A76-39480**      **Geothermal energy for power generation.** J. W. Tester (California, University, Los Alamos, N. Mex.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 19-25. 17 refs. ERDA-sponsored research.

The magnitude of the geothermal resource base for natural hydrothermal systems and for artificially stimulated dry hot rock systems is evaluated for the United States with respect to necessary technology required for development. The utilization of geothermal fluids ranging in temperature from 100 to 300 C is discussed from a thermodynamic and economic viewpoint. Direct steam flashing and a number of binary-fluid Rankine cycle arrangements employing nonaqueous working fluids are compared as to the performance of their power conversion cycle. In addition, the status of component development for advanced geothermal conversion systems is discussed. A generalized cost model is developed for predicting electric generating costs as a function of characteristics of the resource, including geothermal temperature gradient, reservoir capacity, and fluid temperature. (Author)

**A76-39481**      **100 MWe solar energy conversion power plant design.** F. A. Blake (Martin Marietta Aerospace, Denver, Colo.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 26-33. 5 refs. NSF Grant No. AER-75-07570.

The design configuration of a 100 MWe solar energy conversion power plant is presented, together with its projected performance characteristics. A concentrating heliostat with an optical performance falling between the classical parabolic cylinder and the parabola of rotation was selected as the baseline solar collector. The area concentration for the prototype is 1840 overall. The cavity configuration was chosen for the tower-mounted heat receiver because of its near-black-body absorption and its ease of insulation. The condenser will be air-cooled, and a single 100 MWe regenerative nonheat turbine-generator will be used. The thermal collection efficiencies are expected to range from 0.614 to 0.763. A specular reflectivity of 85% is expected to be attainable with current production glass laminated mirrors by using less tinted glass or by decreasing the thickness of the mirrored segment to 2 mm. C.K.D.

**A76-39482**      **Photovoltaic converters.** C. E. Backus (Arizona State University, Tempe, Ariz.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 34-39. 24 refs.

Recent research on solar cells has brought their efficiencies up to about the theoretical limits of about 20-25%. Present research is being directed toward making lower cost, reliable cells for terrestrial applications. Many purification and fabrication processes are being investigated for silicon cells, and other materials such as CdS/Cu<sub>2</sub>S and GaAs are being studied. The national photovoltaic program in the U.S. is aimed at bringing the present cost of cells of \$20 per peak watt down to about \$0.50 per peak watt by 1985. (Author)

**A76-39484**      **A review of underground transmission of the future.** R. W. Samm (Electric Power Research Institute, Palo Alto, Calif.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 55-58.

The projected development of forced cooling, compressed gas, extruded dielectric, and cryogenic underground power transmission systems in the next ten years is discussed. Major advantages and technological difficulties of each type of system are identified. It is expected that taped systems will be uprated to 750 kV and above. These high-capacity cables will probably be more economical than present systems due to the use of synthetic oils in smaller quantities

than the amount of natural oil required by present systems, improved oil storage techniques, and better VAR injection devices. Extruded cable systems in transmission voltages through 345 kV should be available with reliability approaching that of taped cable systems. A major thrust of research and development in this technology is towards elimination of electrical and water treeing. Flexible compressed gas systems with capacities of 345 kV and above, and rigid gas cable systems with similar capacities based on the three-in-one technology are predicted. Resistive cryogenic systems should be commercially available by 1985, at which time superconducting systems may be expected to be on the verge of commercial availability. C.K.D.

**A76-39485**      **Survey of energy storage techniques.** R. Ramakumar (Oklahoma State University, Stillwater, Okla.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 105-110. 34 refs. NSF Grant No. AER-75-00647.

Mechanical, chemical, thermal, and electrical energy storage technologies in current use or under investigation are described, and their specific energies, cost, complexity, and applicability are examined. Mechanical storage systems which are economically viable at present include pumped hydro and compressed-air. Projected costs of superflywheel systems are attractive for short-term (2-3 hr) energy storage. It is recommended that isothermal hydraulic compression be re-examined in the context of modern technology. A variety of economical secondary batteries should become available in the 1980s. Thermal storage will be used mainly to harness solar energy to heat individual buildings. Superconducting magnetic energy storage systems are economically viable only on scales of 1000 MWh and above; calculated delivered energy costs range from 18-86 mills per kWh, depending on operating conditions. Rechargeable fuel systems are expected to offer economical operation over a large size range, and should lend themselves to modular construction. Energy storage in the form of synthetic fuels is not yet economically feasible, and storage costs for hydrogen systems are difficult to ascertain from the information presently available. C.K.D.

**A76-39486**      **Hydroelectric pumped storage.** F. L. Brennan and R. J. Conlon (Stone and Webster Engineering Corp., Boston, Mass.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 111-118. 10 refs.

The pumped hydro storage concept offers many attractive features, including flexibility in meeting peak demands and providing energy in emergency situations, low first cost, negative obsolescence, low operating costs, and high reliability. The design features and operating characteristics of present hydro pumping systems are discussed. Attention is given to considerations affecting plant siting. Future trends in hydro storage technology are examined. Future systems, operating with coal or nuclear base load sources, are expected to be increasingly automated, incorporating sophisticated control systems. A variety of methods for accelerating the machines to synchronous speed prior to connection to the power system are in use or under consideration, including amortisseur-type starts, synchronous or back-to-back starting works, independent starting using pony motors, synchronous pony turbines and motor-generators, and the use of a static frequency changer to supply power directly to the generator leads. Plants with underground storage reservoirs with 600, 1200, or 1800 m heads in one, two, or three stage units are within the present state-of-the-art. Tradeoffs must be made between reservoir size and depth. Pumped hydro systems may be used with tidal, solar, wind, and geothermal base load sources in the future. C.K.D.

**A76-39487** Energy storage through long term flywheel application. C. E. Caveness (California State University, Long Beach, Calif.). In: Energy for the future; Region Six Conference, Tucson, Ariz., April 7-9, 1976, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 119-124. 14 refs.

The electrical application of inertial energy storage requires the transmutation of electrical energy into rotational kinetic energy for storage and its subsequent reconstitution to a usable form of electrical energy. Basic design concept developed are analyzed and application to the industry are discussed. Predicated on advanced technology, flywheel energy storage systems utilizing large composite rotors offer the potential for replacing combustion turbines for utility peak power storage when combined with nuclear or coal-fired electric generating facilities. In addition to oil savings from deleting combustion turbines, total power send-out costs could be lowered significantly. A moderate scenario predicts cumulative oil savings of 570 million barrels of oil by 1995. (Author)

**A76-39500** Resource recovery and recycling handbook of industrial wastes. M. Sittig. Park Ridge, N.J., Noyes Data Corp. (Environmental Technology Handbook, No. 3), 1975. 440 p. \$36.

The process technology presently available for resource recovery and recycling of industrial wastes is discussed. Special attention is given to the environmental effects of the resource recovery procedures described. Comprehensive surveys of techniques used for the separation and treatment of complex urban wastes, ferrous metals, food and beverage industry wastes, glass and ceramics, rubber, plastics and fibers, and paper and wool mill wastes are presented. The recovery of a variety of inorganic and organic chemicals, and the utilization of heat derived from solid, liquid, and gaseous wastes are discussed. (Author)

**A76-39526** A sequential algorithmic approach to synthesizing minimum cost solar collector fields. W. S. Duff (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 18, no. 3, 1976, p. 165-175. NSF Grant No. GI-37815.

A sequential optimization approach to finding minimum cost solar collector fields is presented. Minimum cost fields are found for various values of useful thermal power as measured by the fluid mass flow rate and temperatures in and out of the field. The optimum piping arrangements, field geometries, mixes of collector types, pipe diameters and insulation thicknesses are determined for each minimum cost field. Examples of the application of the optimization approach are also presented. (Author)

**A76-39527** Energy transfer in a large-scale thermal solar power farm. A. B. Meinel (Helio Associates, Inc., Tucson, Ariz.) and M. P. Meinel (Arizona University, Tucson, Ariz.). *Solar Energy*, vol. 18, no. 3, 1976, p. 177-181. 11 refs. NSF Grant No. GI 41895.

Proposals for large-scale thermal solar power farms using distributed collector modules have met with objections concerning energy losses in transporting the heat transfer fluid to, through, and from the many modules involved. We show herein that a large-scale configuration is possible in which the individual modules are the order of 1 km in length, so that a single pair of central feeder pipes is all that is required in the way of heat-losing piping. An equation is derived for the ratio of power output to power consumed that is independent of the collector parameters. (Author)

**A76-39529** Design considerations for solar collectors with cylindrical glass honeycombs. H. Buchberg and D. K. Edwards (California University, Los Angeles, Calif.). (*International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 3, 1976, p. 193-203. 18 refs. NSF-ERDA-supported research.

The paper considers the design of cylindrical glass honeycombs to be placed between the solar absorber and outer cover glass of a solar collector for reducing natural convection and infrared reradiation

heat losses. To optimize the design of a honeycomb structure, i.e., to minimize the cost of solar energy collection, requires the determination of honeycomb solar transmission as a function of incidence angles of solar radiation, infrared effective emittance, cell Nusselt number and cell wall conductance together with a cost estimate. It is found that for a cell diameter no larger than 1.6 cm, increasing the ratio of cell length to cell diameter decreases the infrared effective emittance, but also decreases the solar transmission, requiring the determination of optimal geometries for different operating temperature regimes. (Author)

**A76-39530** Simple thermal decomposition reactions for storage of solar thermal energy. W. E. Wentworth and E. Chen (Houston University, Houston, Tex.). *Solar Energy*, vol. 18, no. 3, 1976, p. 205-214. 10 refs. Research supported by the University of Houston.

Simple thermal decomposition reactions have been investigated for the purpose of solar thermal energy storage. Ten criteria regarding the thermodynamics and kinetics of the reaction and the physical properties of the components of the reaction have been established. One particular reaction, the decomposition of ammonium hydrogen sulfate, has been evaluated in a preliminary manner and appears to satisfy all of the established criteria. The efficiency of storage is high and the decomposition occurs in the vicinity of 500 C. Other compounds such as ammonium halides, alkali and alkaline earth metal hydroxides, carbonates, sulfates and oxides have also been examined. (Author)

**A76-39532** Cost predictions for photovoltaic energy sources. R. M. Moore (RCA, Princeton, N.J.; RCA, Consumer Electronics Div., Indianapolis, Ind.). *Solar Energy*, vol. 18, no. 3, 1976, p. 225-234. 20 refs.

A preliminary assessment of the solar cell cost prediction art has been made, both in terms of a review and analysis of the prior literature and through an extension of these prior studies. The initial step in this evaluation is to develop a self-consistent system of 'reasonable' assumptions concerning the future market environment of solar cell energy sources. The second step is to establish the key assumptions which dominate the cost estimates obtained in prior studies. The results from these first two steps form the basis for judging the relative credibility of the existing cost predictions. An alternative set of cost estimates is generated. These alternative cost predictions are made for single-crystal Si cells (Czochralski vs 'ribbon' growth), current technology Cu<sub>2</sub>S-CdS cells, and a 'generalized' thin-film photovoltaic device. (Author)

**A76-39534** The nonconvecting solar pond applied to building and process heating. D. L. Styris, O. K. Harling (Battelle Pacific Northwest Laboratories, Richland, Wash.), R. J. Zaworski, and J. Leshuk (Oregon State University, Corvallis, Ore.). (*International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 3, 1976, p. 245-251. 13 refs. Contract No. AT(45-1)-1830.

Equations are derived which yield a single set of dimensions for a hypothetical nonconvecting solar pond satisfying a given heating requirement and applied to determining pond dimensions for house heating, winter crop drying and paper processing in the Richland, Washington area. Cost estimates for hypalon-lined pools of these dimensions are compared with costs attributed to conventional thermal energy sources. The cost of ponds is controlled primarily by the quantity of salt necessary for stability. It is shown that unit salt costs as high as 6 cents/kg can be tolerated for large house heating requirements if 342 kg/sq m will create a stable pool. (Author)

**A76-39535** End-clearance effects on rectangular honeycomb solar collectors. D. K. Edwards, J. N. Arnold, and I. Catton (California University, Los Angeles, Calif.). (*International*

*Solar Energy Society, International Solar Energy Congress and Exhibition, Los Angeles, Calif., July 28-Aug. 1, 1976.* *Solar Energy*, vol. 18, no. 3, 1976, p. 253-257. 26 refs. NSF Grant No. GK-35892.

Results are reported of an experimental program to measure the effects of gaps between a honeycomb core and its coverglass and absorber plate. Nusselt numbers up to values of 2 vs Rayleigh number are reported for gaps of 0, 1.5, 2.3, 3.0 and 4.6 mm above and 0 and 1.5 mm below a 19 mm thick honeycomb core with 4.69 x 40.3 mm rectangular cells. The nontranspired honeycomb system was heated from below and oriented at 0, 15 and 30 from the horizontal with the long dimension of the cells running horizontally. The results indicate that a well-designed honeycomb core will give good performance in a solar collector even with clearance gaps of 1.5 mm above and/or below the core. (Author)

**A76-39537** Performance of diffused vertical multijunction solar cell. M. S. Sodha and A. K. Agarwal (Indian Institute of Technology, New Delhi, India). *Solar Energy*, vol. 18, no. 3, 1976, p. 265-268. Research supported by the Council of Scientific and Industrial Research of India and NSF.

The paper presents an analytical investigation of the conversion efficiency of a diffused vertical multijunction solar cell, neglecting the effects of surface recombination velocity and non-Ohmic contacts. Optimal efficiency was sought in relation to the width of the p and n regions and the magnitude of the built-in field. It was found that the conversion efficiency was largely dependent on the built-in field which in turn is a function of the equilibrium carrier concentration profile. B.J.

**A76-39538** Tower reflector for solar power plant. A. Rabl (Argonne National Laboratory, Argonne, Ill.). *Solar Energy*, vol. 18, no. 3, 1976, p. 269-271. 5 refs. ERDA-supported research.

The power tower of a solar power plant uses a large field of heliostats for collecting light and transmitting it to a central absorber on top of a tower. Since tower height is in the range 100-500 m, there are problems associated with heat transfer from the absorber at the top of the power plant to the base of the tower. This paper proposes a tower reflector method for transporting energy in the form of solar radiation all the way to the power plant without excessive optical losses. The incoming sunlight would be reflected from a field of heliostats towards a common focal point in the sky. Before reaching this point, the light is intercepted by a second reflector which directs all rays to a focal point on the ground. B.J.

**A76-39560** Introduction of an additive in the form of an aqueous solution of potassium carbonate at high temperatures and concentrations. M. A. Styrikovich, A. V. Zagorodnikh, V. E. Kartun, I. L. Mostinskii, R. S. Nekhoroshev, V. R. Pesochin, E. G. Smirnova, and V. I. Stepanov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 13, Nov.-Dec. 1975, p. 1261-1266.) *High Temperature*, vol. 13, no. 6, May 1976, p. 1162-1166. 5 refs. Translation.

The advantages and shortcomings of introducing an additive in the form of aqueous solutions of K<sub>2</sub>CO<sub>3</sub> of 50 and 75% concentration into the combustion chamber of an open-cycle MHD facility are discussed. A system is proposed for producing and introducing an aqueous solution of K<sub>2</sub>CO<sub>3</sub> with a concentration of 73 plus or minus 1 at.% at 360 C into the combustion chamber of a MHD facility of the type U-02. Other concentrations considered are 50 at.% at 20 C and 50 at.% at 270 C. The solutions are atomized in the combustion chamber by means of a pneumatic injector with a nozzle diameter of 0.5 mm. Experimental results are presented regarding measurement of the conductance of combustion products along the length of the combustion chamber, its dependence on temperature, pressure, and concentration of the solution introduced. The limits of normal regimes for the operation of the evaporator are determined. S.D.

**A76-39709** The role of physics in solving environmental problems. W. J. Megaw (York University, Downsview, Ontario, Canada). *Physics in Technology*, vol. 7, July 1976, p. 154-159. 13 refs.

Environmental protection problems where physicists can put their skills to immediate use are surveyed. Problems in cleanup of off-gases and alleviation or prevention of industrial fog and smog are discussed extensively, and dispersion of pollutants and particulates over a wider area with transport of pollutants to areas remote from the polluting site is covered. The effect of aircraft emissions and upward-transported fluorocarbons (from commercial aerosols) on the ozone layer is examined. It is pointed out that the chemical inertness of fluorocarbons does not yet rule out possible harmfulness of these substances as they diffuse through the troposphere. Weather modification and its possible beneficial and harmful effects, prevention of unwanted weather modification by pollutants, air pollution control, and energy problems are also discussed. R.D.V.

**A76-39724** The cyclo train gravity drive in local traffic - Advantages and problems (Die Cyclobahn Gravitationsantrieb im Nahverkehr - Vorteile und Probleme). V. Jung. *Zeitschrift für Eisenbahnwesen und Verkehrstechnik - Glaser's Annalen*, vol. 100, June 1976, p. 192-200. 12 refs. In German.

It has been proposed to use gravity as force for the propulsion of vehicles. A track which consists of uphill and downhill sections is to be used. The stations are to be located at positions of the highest elevation. The potential energy of the vehicle at the station is to provide the energy for the propulsion of the vehicle. The kinetic energy obtained during the motion of the vehicle on the downhill section is utilized for the propulsion of the vehicle on the uphill section. Additional energy in one form or another is only required to compensate for energy losses due to frictional forces. Approaches for the implementation of the basic ideas in a subway system are discussed, taking into account a comparison of economic factors for the new system and a conventional subway system. G.R.

**A76-39777** Progress in Nd:YAG lasers. H. G. Danielmeyer (Max-Planck-Institut für Festkörperforschung, Stuttgart, West Germany). In: *Lasers*. Volume 4. New York, Marcel Dekker, Inc., 1976, p. 1-71. 180 refs.

This review of advances in Nd:YAG lasers stresses the progress in the quantitative understanding of pump efficiency, thermal effects, fluorescence quenching, instabilities, mode locking, single frequency operation, and frequency stabilization. Material growth is discussed in terms of physical properties, absorption, fluorescence and laser lines, and energy transfer. Particular attention is given to optical pumping and degradation, pump lamps and geometries, as well as gain, threshold, and slope efficiency. Other topics include relaxation oscillations, spiking, and Q-switching and dumping. The future of Nd:YAG as the most successful solid-state laser material will depend on improvements with other materials mainly in two areas: destructive effects for high-power operation and fluorescence quenching for integrated optics. S.D.

**A76-39843** \* # Conceptual design of reduced energy transports. M. D. Ardema, M. Harper, C. L. Smith, M. H. Waters, and L. J. Williams (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Aircraft*, vol. 13, Aug. 1976, p. 545-550. 8 refs.

The paper reports the results of a conceptual design study of new near-term fuel-conservative aircraft. A parametric study was made to determine the effects of cruise Mach number and fuel cost on the optimum configuration characteristics and relative economic performance. Supercritical wing technology and advanced engine cycles were assumed. For each design, the wing geometry was selected to maximize an economic figure of merit which reflects the potential rate of return on investment. Based on the results of the parametric study, a reduced energy configuration was selected. Compared with existing transport design, the reduced energy design has a higher aspect ratio wing with lower sweep, and cruises at a slightly lower Mach number. It yields about 30% more seat-miles/gal



than current wide-body aircraft. At the higher fuel costs anticipated in the future, the reduced energy design has about the same economic performance as existing designs with the same technology level. As an example of a far-term technology application, a design with a composite material wing was also investigated. (Author)

**A76-39849 Oil from shale and tar sands.** E. M. Perrini. Park Ridge, N.J., Noyes Data Corp. (Chemical Technology Review, No. 51), 1975. 317 p. 219 refs. \$36.

The book provides a comprehensive survey of methods for processing oil shales and tar sands based on U.S. patent literature. Detailed technical information on most processes patented since 1960 is given; some methods for which patents were issued prior to 1960 are included. Oil shale retorting processes using gas combustion and solid heat transfer media are described. Hot water, cold water, and hot-water clarification processes for the separation of tar sands are included, as are processes for the recovery of aluminum, vanadium, and zirconium. A guide to the inventors of major refining and retorting processes is given, together with a list of companies holding patents to such processes. C.K.D.

**A76-39904 # Geothermal energy - Methods and materials.** J. C. Bresee (ERDA, Div. of Geothermal Energy, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 11th, San Diego, Calif., July 14-16, 1976, Paper 76-455.* 10 p.

Geothermal energy technology is reviewed with discussions of resource and reservoir management, exploration techniques (e.g., infrared measurements to detect surface hot water), petroleum drilling techniques, brine reinjection and the development of electric and nonelectric uses of geothermal energy. Materials (with emphasis on brine technology) and heat transfer problems associated with geothermal energy utilization are considered. B.J.

**A76-40125 Introduction to hydrogen energy.** Edited by T. Nejat Veziroglu. Coral Gables, Fla., International Association of Hydrogen Energy, 1975. 173 p. \$30.

The papers collected in this volume address some of the main questions concerning the production, utilization, economics, and future outlook for hydrogen as a major energy source. Topics discussed include energy sources suitable for hydrogen production; thermochemical and electrolytic production of hydrogen from water; hydrogen storage and transmission methods; general analysis of hydrogen-oxygen utilization devices, general combustion characteristics of hydrogen; a survey of the potential use of hydrogen in iron and steel production, gasification of coal and shale, and in the transportation sector; an assessment of hydrogen-fueled naval ships; and mechanisms and strategies of market penetration for hydrogen. P.T.H.

**A76-40180 Energy management for fuel conservation in transport aircraft.** R. F. Stengel and F. J. Marcus (Analytic Sciences Corp., Reading, Mass.). (Institute of Electrical and Electronics Engineers, National Aerospace and Electronics Conference, Dayton, Ohio, May 18, 1976.) *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-12, July 1976, p. 464-471. 11 refs. Contract No. F33615-75-C-3039.

Optimal control techniques have been applied to the problem of conserving fuel in C-141A aircraft. Numerical results form the basis for designing an on-board energy management system, which can automatically command fuel-optimal climb, cruise, and descent flight paths for a majority of this aircraft's missions. (Author)

**A76-40182 Dynamics of wind generators on electric utility networks.** C. C. Johnson and R. T. Smith (Southwest Research Institute, San Antonio, Tex.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-12, July 1976, p. 483-493. 14 refs.

Dynamic interaction of wind-turbine-driven generators on electric utility networks was studied by computer simulation. Nonlinear representations of wind-turbine and various drive train elements and Park equation representations of synchronous and induction generators were implemented. An infinite capacity network was assumed. Time history responses for various system configurations were

computed. Best results are obtained by interposing rate or damped compliant couplings between the wind turbine and a synchronous generator. An aerodynamically limited turbine driving an induction generator exhibited good response without the need for blade pitch control, but at the cost of increased turbine rotor diameter. (Author)

**A76-40277 The C.G.E. circulating zinc/air battery - A practical vehicle power source.** A. J. Appleby and M. Jacquier (Compagnie Générale d'Electricité, Centre de Recherches, Marcoussis, Essonne, France). *Journal of Power Sources*, vol. 1, July 1976, p. 17-34. 25 refs. Research supported by the Société des Accumulateurs Fixes et de Tractions.

The currently proposed electric vehicle power sources are briefly summarized, and compared with the circulating zinc/air system. Based on current laboratory test data, this system should be capable of 110 Wh/kg, 80 W/kg in a 1 ton urban vehicle and up to 125 Wh/kg in heavy duty applications, with lifetimes up to twice those for lead-acid systems. Despite its comparatively low recharge efficiency, (40 per cent) it will be capable of overall per km costs comparable to those for gasoline powered vehicles at current U.S. or untaxed European gasoline prices. (Author)

**A76-40292 Utilisation of geothermal energy in Iceland.** J. S. Gudmundsson (Atomic Energy Research Establishment, Chemical Engineering Div., Harwell, Oxon, England). *Applied Energy*, vol. 2, Apr. 1976, p. 127-140. 22 refs.

The present and future uses of geothermal energy in Iceland are reviewed. The classification of geothermal areas is mentioned and their potential estimated. High temperature areas may be able to sustain the production of 20 MW/sq km of electricity for at least 50 years. The potential of the 17 high temperature areas is almost 6000 MW, which is substantially greater than that of the 250 low temperature areas. However, practically all the hot water used for district heating and greenhouse farming is supplied by low temperature areas. About half the population of Iceland enjoys geothermal district heating at the cost of 35% that of comparable fuel oil heating. Utilization of high temperature areas is relatively recent. Saturated steam from these areas is used for industrial purposes and a 60 MW geothermal power plant is being constructed. (Author)

**A76-40294 Energy as a basis of our civilization (Energie - Grundpfeiler unserer Zivilisation).** A. Buch. *Energie*, vol. 28, Apr. 1976, p. 107-112. In German.

Relations between the energy consumption in a nation and the standard of life are examined and developments regarding the consumption of energy during the time from 1972 to 2000 are considered, taking into account conditions in West Germany. Attention is given to the desirability to make greater use of available domestic resources related to coal and lignite. A description is given of suitable development projects which will make it possible to obtain energy carriers in a suitable form from domestic resources. New technologies discussed are related to a utilization of solar energy, wind power, geothermal resources, and the energy of the tides. G.R.

**A76-40295 Systems for low-emission energy production (Systeme für emissionsarme Energieerzeugung).** H. Koch and H. N. Sharan (Gebrüder Sulzer AG, Winterthur, Switzerland). *Energie*, vol. 28, Apr. 1976, p. 113-118. 9 refs. In German.

A description is presented of the results of emission measurements which were conducted in power plants employing gas and steam turbines. The measurements were carried out in connection with an investigation concerning the effects produced by a variation of certain design parameters. A mechanism for the formation of nitrogen oxide from the nitrogen contained in the fuel is discussed. Attention is given to examples for steam-gas installations which provide a higher efficiency combined with lower amounts of emissions and smaller thermal effects on the environment. G.R.

**A76-40296 The utilization of solar energy in Switzerland (Nutzung der Sonnenenergie in der Schweiz).** R. Hübner. *Energie*, vol. 28, Apr. 1976, p. 119-122. 7 refs. In German.

Research work conducted at two technical universities in Switzerland is considered. The investigations have shown that even at latitudes corresponding to those of Europe an economical use of solar energy for the heating of houses is possible if a good thermal insulation for the house is provided along with solar collectors of appropriate design. Heating throughout the entire year without a use of additional heat sources is feasible if special heat reservoirs are employed in connection with heat pumps. Attention is given to details concerning solar collectors, thermal insulation, and the heat reservoir. The design and the operation of the solar heating systems for houses in three experimental projects are discussed. G.R.

**A76-40297** The utilization of geothermal energy (Über die Nutzbarmachung geothermischer Energie). K. Beck. *Energie*, vol. 28, Apr. 1976, p. 131-134, 8 refs. In German.

The forms in which geothermal energy sources are currently utilized are considered and approaches are discussed for discovering and exploiting additional sources of geothermal energy. Geothermal energy can appear in the form of hot water, dry steam, and a steam-water mixture. Attention is given to problems of heat transport and distribution, taking into account approaches for the solution of these problems. G.R.

**A76-40301** Power units for the future. B. B. Leverton (Rolls-Royce Motors, Ltd., London, England). *Transport Engineer*, May 1976, p. 11-13.

Competition for the diesel piston engine from viable rivals (regenerative gas turbine, Stirling cycle engine, Rankine cycle engine, and modified gasoline engines and steam engines) is evaluated. Arbitrary importance and merit ratings are established for various performance parameters (fuel consumption, reliability, environmental effects and emissions, maintainability and serviceability, overhaul life), and comparisons are made of operating costs, size and weight, noise, and thermal efficiencies. It is predicted that the competition will continue to spur further improvements in diesel engines, which will continue to dominate the field for some time to come, as industry investment in its development and improvement will exceed that for the competition, which will continue to be hurt by the present inflation and fuel cost picture. R.D.V.

**A76-40303** Advancing electric vehicles. G. G. Harding (Joseph Lucas, Ltd., England). *Transport Engineer*, May 1976, p. 21, 22.

An electric-powered vehicle development program is described in outline. While progress in the development of an alternative battery to the lead-acid type for this application is disappointing, a satisfactory test bed proved well in road tests and led to working models, including trucks, buses, and taxis, leased out to cooperating automotive fleet enterprises for testing under real road conditions. The converted vehicles are equipped with series-wound motors (216 V), thyristor controllers, and advanced lightweight lead-acid batteries. Braking, acceleration from stop, driving range, and top speed (over 50 mph) are deemed encouraging. A slide-in battery pack tray was developed. Constraints on the marketability of types of battery-powered vehicles in the period ahead are considered. R.D.V.

**A76-40305** Energy conservation. P. T. Hinde and S. D. Probert (Cranfield Institute of Technology, Cranfield, Beds., England). *Applied Energy*, vol. 2, Jan. 1976, p. 17-37, 22 refs.

Current energy sources and consumption patterns are reviewed, with emphasis on the UK. The main technological approaches to energy conservation including more efficient conversion of fuels to mechanical and electrical power utilization of waste heat, reducing energy requirements for materials and manufacturing, and reducing distribution/storage losses and heat losses from structures are considered. Potential savings resulting from exploitation of novel energy resources are also examined. Sociotechnical aspects of energy conservation are discussed, with particular reference to transport and per capita consumption of materials/manufactured goods. It is concluded that very substantial savings could be made in these areas. Despite the additional environmental benefits associated with many such savings, their political feasibility is judged to be low. Sug-

gestions are made for realistic legislation that could be introduced to effect savings by individual users with minimum capital expenditure. (Author)

**A76-40306** Long-term prospects for compressed air storage. I. Glendenning (General Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, England). *Applied Energy*, vol. 2, Jan. 1976, p. 39-56, 5 refs.

The state-of-the-art of compressed air storage (CAS) is examined, with special attention given to the 290 MW gas installation undertaken by the German utility Nordwestdeutsche Kraftwerke (NWK). The ability of conventional CAS schemes to operate in conjunction with a nuclear power plant, storing energy for 6-8 hours and generating for 12-16 hours per day is considered. It is observed that in conventional schemes there is no true energy storage, since all the compression energy is rejected as low grade heat at the intercoolers and aftercooler in order to store the compressed air at approximately ambient temperatures. A scheme in which the air is transferred to a pebble bed store from the compressor at the compressor delivery temperature and pressure to effect true energy storage is suggested. The plant ratings and storage requirements for an 8 GWh scheme are analyzed. It is estimated that the cost per kilowatt hour for this scheme will be well within requirements for use in conjunction with nuclear power by 2000. C.K.D.

**A76-40308** An energy overview - Today and tomorrow. W. T. Slick, Jr. (Exxon Co., U.S.A., Houston, Tex.). (Society of Petroleum Engineers of AIME, Annual Fall Technical Conference and Exhibition, 50th, Dallas, Tex., Sept. 28-Oct. 1, 1975.) *Journal of Petroleum Technology*, vol. 28, Jan. 1976, p. 7-10.

The status of energy resources in the U.S. is reviewed with particular reference to the country's goal of energy self-sufficiency. It is assumed that enough oil imports will be available to balance demand, but that gas imports will be limited. An evolutionary development of government energy policy is envisioned. An analysis of energy demand and supplies reveals an urgent need for resolving the country's energy problems and making the most of available energy capabilities. The country has the resource base and technological capability for making great strides toward energy self-sufficiency, but one must resort to sound planning, technical development, physical effort, and unprecedented capital investments. S.D.

**A76-40309** Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology. J. R. Bowden (Conoco Coal Development Co., Stamford, Conn.). (Society of Petroleum Engineers of AIME, Annual Fall Technical Conference and Exhibition, 50th, Dallas, Tex., Sept. 28-Oct. 1, 1975.) *Journal of Petroleum Technology*, vol. 28, Jan. 1976, p. 11-15.

A quick restatement of the resource base for coal is that there is absolutely no problem in availability for any legitimate domestic energy requirement within the next 20 years. A discussion of recent technological advances shows that there is no technical barrier to immediate gasification of coal and that liquefaction by adding hydrogen to coal to desulfurize the coal and yield a liquid fuel does have promise of producing clean Btu's more cheaply than high-Btu gasification processes. Costs and policy are discussed in terms of thermal efficiency of the process and capital requirements per clean heating unit produced. During the middle years of the 20-year forecast period, coal conversion plants are expected to be built to verify technology now available and to act as insurance against unforeseen failure of oil and gas supply. S.D.

**A76-40310** Oil shale development - Status and prospects. J. A. Whitcombe (Oil Shale Corp.). (Society of Petroleum Engineers of AIME, Annual Fall Technical Conference and Exhibition, 50th, Dallas, Tex., Sept. 28-Oct. 1, 1975.) *Journal of Petroleum Technology*, vol. 28, Jan. 1976, p. 16-20.

The paper discusses the prospects of oil shale in the U.S., with special emphasis on the status of oil shale development and on the

contribution that oil shale can make to the country's energy supply during the next 20 years. The discussion covers oil shale recovery processes, commercial plant cost projections, and potential development of oil shale industry. The oil shale reserves are enormous and they can be developed in harmony with environmental goals. Building large-scale oil shale production capability on a short-term schedule is a complex task requiring detailed planning by government and industry. The country must therefore adopt an energy policy which would provide for development of supplemental energy sources to replace the waning supplies of conventional oil and gas. S.D.

**A76-40311**      **Outlook for new energy sources.** S. H. Clark (Sherman H. Clark Associates, Menlo Park, Calif.). (*Society of Petroleum Engineers of AIME, Annual Fall Technical Conference and Exhibition, 50th, Dallas, Tex., Sept. 28-Oct. 1, 1975.*) *Journal of Petroleum Technology*, vol. 28, Jan. 1976, p. 21-23.

The characteristics of geothermal sources, solar energy, fusion power, and winds and tides as contributors of energy supply are discussed. The outlook for all the new sources combined indicates a minimal market share for the next decade and possibly for two decades, with a rapidly increasing share thereafter that will rise to 25-50% of the energy supply in 50 years. However, these sources will not prevent the real cost of energy from rising fairly steeply for the next 10 to 15 years, they will not break up OPEC in that period, and they are not a substitute for conventional nuclear power, federal offshore continental shelf resources, or deregulation of gas prices and decontrol of oil prices. S.D.

**A76-40312**      **Heat recovery from multi-turbine installations.** A. E. Smith (Exxon Co., U.S.A., Tyler, Tex.) and G. T. Schaefer, Jr. (Exxon Co., U.S.A., Baytown, Tex.). (*Society of Petroleum Engineers and AIME, Annual Fall Technical Conference and Exhibition, 50th, Dallas, Tex., Sept. 28-Oct. 1, 1975.*) *Journal of Petroleum Technology*, vol. 28, June 1976, p. 639-644. 5 refs.

An approach is presented for the process and mechanical design of a system that recovers heat energy from the exhaust gases of parallel turbines and uses this energy in a gas-plant process. Attention is focused on major design criteria and concepts for successful energy recovery systems at two Exxon gas processing plants. The discussion covers heat-transfer fluid, heat-exchanger design, exhaust collection, supplemental firing, stack design, special structural and insulation requirements, automatic control system, and actual field installations. The considerations should serve only as a foundation and guide for extending the concept to other energy recovery opportunities. S.D.

**A76-40313**      **Power recovery from in-situ combustion exhaust gases.** D. L. Stinson (Wyoming University, Laramie, Wyo.), H. C. Carpenter (ERDA, Laramie Energy Research Center, Laramie, Wyo.), and J. M. Cegielski, Jr. (John Zink Co.). (*Society of Petroleum Engineers of AIME, Rocky Mountain Regional Meeting, Denver, Colo., Apr. 7-9, 1975.*) *Journal of Petroleum Technology*, vol. 28, June 1976, p. 645-650. Research supported by the U.S. Bureau of Mines.

Results are presented for a field evaluation of the use of a small gas-combustion turbine generator set to recover power from in situ combustion exhaust gases. Facilities were added to a gas-combustion turbine to permit the introduction of the produced gases into the combustion chamber, the removal of the compressed air from the compressor section, fuel injection into an air-rich region of the combustion chamber to insure satisfactory operation of the turbine, and proper mixing of the produced gases with air and the hot combustion gases produced by burning fuel in the combustion chamber. These objectives were accomplished using a combustion-chamber extension coupling and a combustion-chamber extension. Test results indicate that as much as 90% of the energy required to operate the turbine can be derived from normally incombustible produced gas. Foul-smelling compounds usually found in produced gases can be destroyed effectively by passing them through a gas-combustion turbine. For effective utilization of the produced gases the expansion turbine should be operated near its maximum temperature. S.D.

**A76-40314**      **Geothermal energy - An industry appraisal.** H. J. Olson and W. M. Dolan (Amex Exploration, Inc., Denver, Colo.). (*American Mining Congress, Annual Meeting, San Francisco, Calif., Sept. 30, 1975.*) *Geothermal Energy*, vol. 4, Jan. 1976, p. 12, 13, 15-18.

World usage of geothermal power has doubled since 1972. The paper briefly examines the nature of the geothermal resource, prospecting concerns, production practice, and marketing aspects. Particular attention is devoted to environmental concerns, geothermal's probable abundance, investment and revenue timing compared to mining, and applicable land together with legal and institutional considerations. The geothermal industry is beginning to receive the beneficial attention it deserves. Requirements are formulated so that geothermal can provide the country with important amounts of energy by 1990, be acknowledged as one of the cleanest and most desirable sources of energy, and be compatible with other land uses. S.D.

**A76-40315**      **The electric and nonelectric geothermal industry in the United States.** R. Peterson, N. El-Ramly, and J. M. Dermengian (Hawaii University, Honolulu, Hawaii). *Geothermal Energy*, vol. 4, Jan. 1976, p. 20-24.

In the worldwide electric and nonelectric geothermal industry estimated by El-Ramly and Peterson (1975), the relative absence of nonelectrical applications in the U.S. is in contradiction to the experience of the rest of the world where 75% of the use of geothermal fluids is in nonelectric categories. In this paper, the Waring-Blankenship-Bentall (WBB) Report data are analyzed in order to obtain a more realistic and accurate picture of the geothermal industry in the U.S. The results indicate that it is possible to translate some of the WBB Report categories into the categories proposed by El-Ramly and Peterson (1975). If the annual utilization factor is 35% for agriculture and 50% for industry, the WBB Report data can be used to revise the status of the U.S. in the worldwide geothermal industry. As a result, the nonelectric geothermal industry is roughly 75% of the total industry in both the U.S. and the rest of the world. S.D.

**A76-40316**      **Geothermal energy - A new power source for developing countries.** M. Fisher (American Geothermal Energy, Inc.; A. D. Gilhart and Co., Inc., New York, N.Y.). (*National Journal*, Sept. 1975.) *Geothermal Energy*, vol. 4, Jan. 1976, p. 36-39.

Geothermal energy has immediate practical application in developing countries, for the size of geothermal power stations can be designed to fit the scale of electrical supply systems efficiently and economically. Following a discussion of geothermal energy and dry steam, the paper reviews the standards to be met by geothermal reservoirs, existing installations, and hot power applications. Other topics include exploration by satellite, gravity and magnetic surveys, seismic evidence, electrical exploration, and detection by direct heat. The global increase in the price of crude oil has made geothermal power competitive even under relatively moderate reservoir temperature conditions. Newly developing countries are not burdened with the energy systems of the past, so that they may be able to show new and better ways to develop earth resources of energy. S.D.

**A76-40317**      **Worldwide geothermal energy resource development.** P. K. Saint (California State University, Fullerton, Calif.) and A. Jasso (Theta Associates, Huntington Beach, Calif.). *Geothermal Energy*, vol. 4, Feb. 1976, p. 5, 8-14, 17 refs.

The paper gives a review of the state of geothermal development and utilization over the world. The major countries and areas of the world where geothermal resources are being developed are examined in turn, describing the status of exploration efforts and on-going operations and their output and applications. A map is provided showing worldwide geothermal resource development in terms of (1) existing geothermal power production, (2) geothermal power under test or construction, (3) nonelectric uses of geothermal energy, and (4) on-going geothermal exploration. P.T.H.

**A76-40319** TRW sees promise in geothermal energy - A look at East Mesa. D. L. Mueller. *Geothermal Energy*, vol. 4, Apr. 1976, p. 8, 9, 11-14, 16. 7 refs.

Detailed design of a geothermal energy test facility, to be located at East Mesa in the Imperial Valley, Calif. and administered by the U.S. Bureau of Reclamation, is under way. An experimental 10 MWe power plant is also under consideration for construction at this site. The Mesa field was selected because its characteristics are representative of a number of known geothermal resource areas. The reservoir, lying at depths of 4200 to 8200 ft, has a fluid temperature of about 350 C. Dissolved solids range from 3000 to 20,000 ppm. A binary energy conversion system has been selected; critical technology has been identified as corrosion protection, heat exchangers, and downhill pumps. C.K.D.

**A76-40320** Geothermal energy - An integrated use plan. D. G. Swink, R. J. Schultz, and A. J. Oswald (Idaho National Engineering Laboratory, Idaho). *Geothermal Energy*, vol. 4, Apr. 1976, p. 21-25.

The Raft River Demonstration Project for geothermal energy is discussed. The direct utilization of low temperature (less than 300 F) geothermal water in the potato dehydration, manure processing, cattle feedlot, greenhousing, fish farming, meat packing, and tree breeding industries will be investigated. These industries will form a symbiotic system with a proposed 10 MWe geothermal binary cycle power plant which will utilize most of the enthalpy available in the geothermal fluid in a cascading temperature plan. The processes will be closely coupled to minimize enthalpy losses. C.K.D.

**A76-40321** Great Britain - A geothermal prospect. P. Morgan (New Mexico State University, Las Cruces, N. Mex.). *Geothermal Energy*, vol. 4, May 1976, p. 8-12. 16 refs.

Although the British Isles are disfavored on tectonic and geological grounds as a promising area for practical exploitation of geothermal resources, heat flow values published for various sites in England, Wales, and southern Scotland indicate that geothermal power may be available for direct utilization of hot water at those sites, if not for power generation. Data obtained with the Na-K-Ca geothermometer are reported, tabulated, and indicated on a map. Great potential for direct utilization of hot water for agricultural, domestic, and industrial uses is seen in connection with the abundance of surface and subsurface water, but power production is considered unrealistic at the present level of technology, with some promise if dry hot rock technology undergoes suitable development. R.D.V.

**A76-40322** Coal R & D demands greater industry involvement. C. Nolden. *Coal Mining and Processing*, vol. 13, Jan. 1976, p. 52-56.

Allocations of research and development (R&D) funds in the coal industry are surveyed, and funding practices are reviewed. Greater participation by the coal industry companies in R&D funding is urged, including cost-sharing contracts with the government and cooperative agreements with each party paying its own costs on the project. Management of the U.S. Bureau of Mines Annual Operating Plan is described. Allocation of \$45 million includes \$33 million for deep mining work, \$8 million for surface mining work, and \$3.1 million for special studies. Health and safety aspects of the program are covered, and coal conversion efforts are geared toward studies of liquefaction, high-Btu gasification, low-Btu gasification, advanced power systems, direct combustion techniques and magnetohydrodynamic (MHD) direct conversion plants. Coal vs natural gas as MHD medium and development of clean boiler fuels from coal are also discussed. R.D.V.

**A76-40323** Coal liquefaction gains prominence. E. J. Ferretti. *Coal Mining and Processing*, vol. 13, Feb. 1976, p. 64, 65 (4 ff.).

A history of the development of coal liquefaction processes is

presented. The coal pyrolysis, Pott-Broche, Bergius, and Fischer-Tropsch processes are described. A brief discussion of the chemistry of pyrolysis, hydrogenation, solvent extraction, and synthesis is presented. The status of major process development efforts, including the COED process, solvent refining, Coalcon hydrocarbonization, COSTEAM, and the Console synthetic fuel and Synthoil processes, is examined in detail. C.K.D.

**A76-40324** Basic considerations in coal liquefaction. II. E. J. Ferretti. *Coal Mining and Processing*, vol. 13, Mar. 1976, p. 55-57.

Major coal liquefaction processes, suitable catalysts, solids/liquids separation techniques, process wastes cleanup, and marketing and cost considerations are discussed. The hydrocarbonization dry coal liquefaction process is outlined. Advantages of silica-promoted cobalt/molybdenum on alumina catalyst and molten zinc chloride catalyst are indicated. Filtration, centrifugation, solvent dilution and solvent precipitation, coking of the coal liquefaction reaction mass, vapor stripping, hydrocarbonization, magnetic separation, and hydrocycloning (with hydroclones) are discussed among techniques for separating solids from liquid products. Scrubbing of off-gases with water, amine solutions, or carbonates, and cleanup of effluent water are discussed briefly. Markets and costs for coal-derived liquid fuels and other hydrocarbons are compared. R.D.V.

**A76-40326** Hydrogen and nuclear power. N. J. D. Lucas (Imperial College of Science and Technology, London, England). *Energy Policy*, vol. 4, Mar. 1976, p. 25-36.

Demonstrating that an electricity supply system depending on nuclear fuel for the primary energy input can always benefit from some synthesis of a chemical fuel such as hydrogen, the author compares the benefits of using hydrogen within the electricity supply system with those of using it outside the system, in local boilers and prime movers. He concludes that over a wide range of circumstances there is a case for a hydrogen supply system linked with the electricity supply. A tentative estimate suggests the size of the industry might be similar to the existing natural gas industry. (Author)

**A76-40327** Energy costs and society - The high price of future energy. A. J. Appleby (CNRS, Laboratoire d'Electrolyse, Bellevue, Hauts-de-Seine, France). *Energy Policy*, vol. 4, June 1976, p. 87-97. 37 refs.

An analysis of energy economics from the present through 2000 is presented. It is estimated that the cost of energy will be about \$4.00/GJ by the end of the century, and may be as high as \$4.50/GJ for coal-based energy and \$6.00/GJ for nonfossil hydrogen, depending on the rise of interest rates. If overall energy demand grows at the same rate as the GNP, energy costs may account for 26-37.5% of the GNP at the turn of the century. It is argued that maintenance of the current structure of industrial society and provision for a capital and materials intensive nonfossil fuel economy are incompatible. A set of guidelines for the restructuring of industry to de-emphasize energy-intensive production is given, with particular attention directed to the development of more efficient means of transportation. Conservation approaches at the residential, commercial, and industrial levels are suggested. C.K.D.

**A76-40328** Europe and the cost of energy - Nuclear power or oil and gas. P. R. Odell (Erasmus Universiteit, Rotterdam, Netherlands). *Energy Policy*, vol. 4, June 1976, p. 109-118. 8 refs.

Faced with the prospect of an 'energy gap' in the medium term future, the planners of Western Europe have tended to think in terms of nuclear power as the only practicable source capable of meeting demand. This paper strongly contests that view, pointing out that the development of an energy economy based on oil and gas supplies indigenous to Western Europe is likely to be 2-3 times cheaper than the nuclear option. Since a relatively simple analysis points to a strong cost differential in favor of the oil and gas option, the author

argues that the situation should be examined in a more refined and sophisticated way, to see if that conclusion is valid. The unthinking acceptance of the nuclear future could prove very expensive for Europe. (Author)

**A76-40329**      **Energy prospects for Eastern Europe.** L. Dienes (Kansas, University, Lawrence, Kan.). *Energy Policy*, vol. 4, June 1976, p. 119-129. 64 refs.

The very high per capita energy consumption of the Comecon countries is partly the result of an inefficient and outdated energy infrastructure. This article examines the efforts of East European planners to modernise their energy structures and satisfy demand. It describes and evaluates the adjustments made in response to the changing relative price of energy and their effects on economic relations within Comecon. The future high price and relative scarcity of energy is likely to have a deleterious effect upon growth rates and living standards in the countries of Eastern Europe and also to increase the political leverage of the Soviet Union. (Author)

**A76-40330**      **Geothermal energy as an 'alternative' source.** J. D. Garnish (Atomic Energy Research Establishment, Energy Technology Support Unit, Harwell, Oxon, England). *Energy Policy*, vol. 4, June 1976, p. 130-143. 51 refs.

The potential of geothermal energy as an alternative energy source is examined. The location and classification of potentially 'exploitable' areas is discussed, and the geological processes responsible for the large thermal gradients required for power production are outlined. Current research and development projects in the field are reviewed, with particular attention given to the Los Alamos experiment investigating the use of hydrofracturing to improve the permeability of a potential dry rock heat source. The costs of developing wet and dry steam resources are assessed. C.K.D.

**A76-40331**      **The economics of energy analysis reconsidered.** M. Common (Southampton, University, Southampton, England). *Energy Policy*, vol. 4, June 1976, p. 158-165. 12 refs.

The paper provides a rebuttal to the contention of Webb and Pierce (1975) that energy analysis is useless for the evaluation of conservation measures and prediction of changes of relative prices, and that it should be abandoned in favor of less misleading economic analysis. It is pointed out that energy analysis can be effectively applied to predict the effect of changes in primary fuel prices on the prices of commodities. It is recommended that the two fundamental forms of energy analysis be recognized, and that the term Energy Accounting be adopted for analyses of the energetics of an existing process or system, and that Thermodynamic Analysis be used to specify analysis of the energetics of a process or system as yet unrealized. C.K.D.

**A76-40332**      **European energy elasticities.** V. Smil (Manitoba, University, Winnipeg, Canada) and T. Kuz (Winnipeg, University, Winnipeg, Canada). *Energy Policy*, vol. 4, June 1976, p. 171-175. 12 refs.

It has become a commonplace that growth of energy demand and GNP have gone hand in hand. In examining the energy elasticity coefficients of a large number of European countries, however, the authors conclude that, not only is there very little sign of any pattern emerging but that there seems little or no evidence for the view that the coefficient will tend over time to approach unity. However, in using regression parameters for individual countries, they find very high correlation over time between energy and GNP growth, suggesting that countries are locked into relatively fixed patterns of energy consumption. (Author)

**A76-40333**      **Could hydraulic rams increase our hydro power potential.** H. Baird (New Brunswick, University, Fredericton, Canada). *Energy International*, vol. 13, July 1976, p. 15-18.

Hydro power turbines for operation with low heads are examined, with attention given to their potential applicability in

tidal power production. Straight flow turbines avoid the need for a deep draft-tube sub-structure, but encounter technological difficulties in the design of a reliable high-speed water seal to isolate the generator. Several successful demonstrations of the bulb-type turbine, in which this problem is circumvented, have been made. A variation in which the peripheral generator is replaced by a large ring gear, with a mating pinion fitted to a conventional generator, has been proposed; however, the cost of the required high-precision gearing is expected to be high. It is recommended that the hydraulic ram be reexamined in the context of tidal applications due to its high efficiency at low heads and its capability of reducing the fluid velocity to zero during each cycle. C.K.D.

**A76-40334**      **Australia examines new routes to solar energy supply.** W. E. Scott. *Energy International*, vol. 13, July 1976, p. 19-22.

Research and development tasks which have been recommended by the Australian Commonwealth Scientific and Industrial Research Organization's solar studies unit are outlined. Special attention is given to the proposed large-scale (one billion GJ per year) production of liquid fuels - primarily ethanol - from vegetable materials. It has been estimated that 250,000 sq km of marginal, unirrigated land could produce the required amount of cellulose. Intensive research and development should also be directed toward solving technological difficulties confronting the design of cost-effective solar collectors using water in the 60-100 C temperature range as the heat transfer fluid. Important improvements in the efficiency of solar collectors could result from the development of low absorptance glass and surface coatings to reduce reflection. C.K.D.

**A76-40335** #      **Mathematical model for coal gasification under pressure. I (Mathematisches Modell zur Kohlevergasung unter Druck. I).** V. Biba, J. Malecha, J. Macak (Vysoka Skola Chemicko-Technologicka, Prague, Czechoslovakia), and E. Klose (Freiberg, Bergakademie, Freiberg, East Germany). *Energietechnik*, vol. 26, Jan. 1976, p. 28-32. 9 refs. In German.

A reaction kinetics model is developed, describing the pressure gasification of coal in oxidation-reduction reactions of the coal with oxygen-water vapor mixtures. The model formulation is based on the coupling of chemical reactions and transport processes and is focused on three processes: the diffusion of reaction gas through the boundary film which surrounds the solid phase (the coal), the diffusion of the reaction gas in the porous system, and the chemical reaction on the phase boundary surface. B.J.

**A76-40336** #      **Mathematical model for coal gasification under pressure. II (Mathematisches Modell zur Kohlevergasung unter Druck. II).** V. Biba, J. Malecha, J. Macak (Vysoka Skola Chemicko-Technologicka, Prague, Czechoslovakia), and E. Klose (Freiberg, Bergakademie, Freiberg, East Germany). *Energietechnik*, vol. 26, Feb. 1976, p. 71-75. 21 refs. In German.

The model considers four reaction zones, including the oxidation zone, the reduction zone, the degasification zone, and the drying zone. The reactions which take place in the various zones are discussed, taking into account the mathematical representation of the process characteristics and suitable model simplifications. Attention is given to a number of specific selected operational cases which were investigated with the aid of the model relations. The obtained computational values are in agreement with practical operational data. G.R.

**A76-40338**      **The heat pump as a means of utilising low grade heat energy.** R. W. James, S. N. Saluja (South Bank, Polytechnic, London, England), and S. A. Marshall (Wollongong, University, Wollongong, New South Wales, Australia). *Building Services Engineer*, vol. 43, Jan. 1976, p. 202-207. 5 refs.

A mathematical model of a vapor compression system is developed to aid predictions of system behavior when operated as heat pump or refrigerator. The model, featuring breakup of the

system into zones (heat exchanger, evaporator, condenser, compressor; boundary layers, media, refrigerant) with time-varying momentum and state equations for each stirred tank in turn, predicts that energy acquired from a low-grade source, energy required to drive the compressor, and energy supplied by the heat pump unit all vary linearly with the temperature of the water entering the evaporator. The performance of the heat exchanger and liquid chiller units were also studied on the basis of the model. A low-grade energy source plus heat pump is recommended on this basis for space heating of office or factory, and year-round domestic heating and cooling using a ground coil buried below the earth's surface during excavations for the building foundations. R.D.V.

**A76-40339** Wind energy in the U.K. R. Rayment (Building Research Establishment, London, England). *Building Services Engineer*, vol. 44, June 1976, p. 63-69. 22 refs.

New analysis of the frequency distribution and geographical variation of wind speeds for the UK are used to produce a new wind-energy map for the UK. This information is then used to illustrate a method for predicting the availability of wind-energy between different wind speeds for any location in the UK. The relevance of this to the operation of aerogenerators in determining their mean annual output and operating time is presented. Using current and estimated costs for conventional and vertical-axis machines, the cost-effectiveness, for applications in housing, is discussed. It is concluded that only vertical-axis machines and a conventional machine large enough to supply several houses stand a chance of being cost-effective. (Author)

**A76-40341 #** Development of automatic control systems for fuel and energy management (Rozvoj automatizovaných systému řízení v resortu paliv a energetiky). M. Drahný, J. Kolombova, P. Ludvíček, J. Španhel, and P. Kohout (Výzkumný Ústav Energetický, Prague, Czechoslovakia). *Energetika*, vol. 26, Feb. 1976, p. 51-54. In Czech.

The paper discusses the goals and principles determining the process of introducing automatic control systems to aid in the management of fuel and energy resources. Problems related to the change-over to automation are examined from the viewpoint of management and administration responsible for such plans. Means at the disposal of the central administrative body are outlined, and plans for their employment are described. Successful implementation of automatic control systems depends on three factors: the availability of qualified personnel, development of a methodology, and procurement of the corresponding technical means. P.T.H.

**A76-40342 #** Fuel effect of repumping hydroelectric power plants (Palivový efekt přecerpacích vodních elektráren). M. Nechleba. *Energetika*, vol. 26, Feb. 1976, p. 67-69. In Czech.

An economic analysis shows that the introduction and use of repumping hydroelectric power plants in the Czechoslovak electrification network would be advantageous. Fuel savings are obtained for repumping efficiencies of up to 73%. At the same time, unidirectional turbines display a higher repumping efficiency than the reversible type machines. P.T.H.

**A76-40343 #** Sensitivity analysis of minimum heat cost (Citlivostní analýza minimální ceny tepla). J. Vastl (Česke Vysoké Učeni Technické, Prague, Czechoslovakia). *Energetika*, vol. 26, Mar. 1976, p. 122-124. In Czech.

The effect of changes in the amount of heat supplied to consumers and changes in investment costs with heat costs are investigated via sensitivity analysis of heat costs. The effect of process variables on the stability of solutions is considered in a single-factor deterministic sensitivity analysis of the problem, with minima of a single component found with all other quantities held constant. The dependence of electric power demand on amount of

heat supplied, the relationship between fuel costs and amount of heat energy supplied, and the dependence of components of minimum heat costs on investment costs of the heat generating plant are investigated. Practical calculations of individual types of minimum heat costs and their sensitivity analysis are studied. R.D.V.

**A76-40351** Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Conference, Frankfurt am Main, West Germany, January 29, 1976, Proceedings (Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Kolloquium, Frankfurt am Main, West Germany, January 29, 1976, Proceedings). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, Mar. 1976, 51 p. In German.

Heat pumps for the heating of dwelling houses are considered along with the characteristics of refrigerants and questions concerning the market prospects for heat pumps. The significance of a use of the heat pump for space-heating applications is studied, taking into account national economy and energy considerations. Attention is also given to the use of dual-source heating systems and thermal reservoirs to avoid system peak loads in the case of heat-pump heating.

G.R.

**A76-40352** Heat pumps for the heating of dwelling houses (Wärmepumpen zur Wohnhausbeheizung). H. Kirn (Badenwerk AG, Karlsruhe, West Germany). (Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Kolloquium, Frankfurt am Main, West Germany, Jan. 29, 1976.) *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, Mar. 1976, p. A 65-A 70. In German.

A description is presented of current heat pump designs for the heating of one-family and smaller multifamily houses. The basic characteristics of heat pump and conventional heating systems are examined, taking into account the reduction of energy requirements connected with a use of heat pumps. The utilization of heat energy sources is discussed, taking into account ground water, surface water, the ground, solar energy, and outdoor air. Attention is given to heat distribution systems, the heat pump compressor, and the supply of warm water.

G.R.

**A76-40353** The use of dual-source systems to avoid system peak loads in the case of heat-pump heating (Vermeidung von Netzlastspitzen bei Wärmepumpenheizungen durch Einsatz bivalenter Systeme). H. Diedrich (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). (Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Kolloquium, Frankfurt am Main, West Germany, Jan. 29, 1976.) *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, Mar. 1976, p. A 71-A 75. In German.

Heating installations must be capable to satisfy maximum heating requirements which are related to low-temperature conditions occurring only on a few days of the year. A dual source heating system makes it possible to use a heat pump with a smaller capacity which has to provide only the amount of heating normally required. In case the heating requirements exceed this amount, additional heat is obtained from a supplementary heater which uses fuel. The economic advantages of such a dual-source system are discussed.

G.R.

**A76-40354** The use of thermal reservoirs to avoid system peak loads in the case of heat-pump heating (Vermeidung von Netzlastspitzen bei Wärmepumpenheizungen durch Einsatz thermischer Speicher). H. Kirn (Badenwerk AG, Karlsruhe, West Germany). (Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Kolloquium, Frankfurt am Main, West Germany, Jan. 29, 1976.) *Elektrowärme International*,

*Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, Mar. 1976, p. A 76-A 78. In German.

The combination of a heat pump with a latent-heat reservoir makes it possible to reduce the power requirements for the heat-pump compressor by about one third and to equalize power demands during the heating period. Excess heat obtained during times with lower heating requirements is stored with the aid of a large water storage tank. If the environmental temperature drops to -3 C, the heat pump withdraws heat from the storage tank. After the temperature of the water has reached 0 C, the latent heat of fusion becomes available. G.R.

**A76-40356** An evaluation of the use of the heat pump for space heating on the basis of national economy and energy considerations (Volks- und energiewirtschaftliche Betrachtung der Wärmepumpe für die Raumheizung). K.-H. Schwarze (Schleswig AG, Rendsburg, West Germany). (Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Kolloquium, Frankfurt am Main, West Germany, Jan. 29, 1976.) *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, Mar. 1976, p. A 84-A 86. In German.

The market potential for heat-pump heating systems in West Germany is investigated. Operational data, costs, and power requirements are examined. A comparative evaluation of heat-pump heating systems and heating systems based on other concepts shows the superiority of the heat-pump systems. G.R.

**A76-40357** Market prospects for heat pumps (Markenchancen der Wärmepumpe). A. Hadenfeldt (Hamburgische Elektrizitäts-Werke AG, Hamburg, West Germany). (Vereinigung Deutscher Elektrizitätswerke und Hauptberatungsstelle für Elektrizitätsanwendung, Kolloquium, Frankfurt am Main, West Germany, Jan. 29, 1976.) *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, Mar. 1976, p. A 86-A 92. In German.

An investigation is conducted concerning the market for heat-pump heating systems during the time from 1976 to 1985, taking into account the construction of new apartment houses, the construction of single and two-family houses, the construction of multifamily houses, and the introduction of heat-pump heating systems as replacement for other types of heating systems. Basic requirements for the use of heat-pump heating systems are discussed. Attention is also given to aspects of competition between the various types of available heating systems, the costs of electric power, and questions related to the required capital investment. G.R.

**A76-40358** Ideas concerning the use of heat pumps (Gedanken zur Wärmepumpenanwendung). P. Kalischer (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, May 1976, p. A 117-A 119. In German.

An employment of heat pumps for space-heating applications provides an approach to save primary energy. The use of heat pumps for the heating systems of big buildings is, therefore, steadily increasing. An employment of heat-pump heating systems in the case of smaller buildings and houses has not taken place because of competitive factors related to the availability of heating systems based on economically priced oil. However, recent increases in the price of fuel oil have changed the competitive situation. It is shown that dual-source heat-pump heating systems can be entirely competitive with other heating systems. In such a system a low-capacity heat pump is used to satisfy average heating requirements. In the case of peak demands on exceptionally cold days, a heating unit based on the combustion of fuel provides an additional heat source. G.R.

**A76-40359** Possibilities and effects of different methods in the operation of heat pumps (Möglichkeiten und Auswirkungen unterschiedlicher Betriebsweisen von Wärmepumpen). H. Diedrich (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im*

*Technischen Ausbau*, vol. 34, May 1976, p. A 119-A 121. In German.

An investigation is conducted concerning the operational characteristics of dual-source heating systems which use an air-to-water heat pump and a heating boiler. In the alternative operational mode the use of either the heat pump or the boiler is controlled with the aid of a switch valve. Questions related to the installation of an air-to-water heat pump into an existing central heating system are considered. The parallel mode of operation for heat pump and boiler is also considered. A description is given of constructional details which will facilitate a subsequent installation of heat pumps in new houses. G.R.

**A76-40360** Requirements concerning the control of heat pumps (Anforderungen an die Regelbarkeit von Wärmepumpen). T. Rinck (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, May 1976, p. A 122, A 123. In German.

An adjustment of the heat supplied by the heat pump to the heat requirements is currently made by means of an approach involving an operation of the heat pump during a certain time interval of a heating cycle. The possibility to optimize the operational characteristics of the system with the aid of a continuous control method is investigated, taking into account pressure ratios, the flow volume, rotational speed, and power requirements. It is found that an improved control method would result in energy savings of about 20%. An improvement in compressor efficiency would reduce the energy consumption by another 20%. G.R.

**A76-40365** Economy of the heat pump (Wirtschaftlichkeit der Wärmepumpe). H. Eickenhorst (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, May 1976, p. A 136, A 137. In German.

An analysis is conducted of the costs which are involved in heating a one-family house by different methods. Attention is given to a conventional oil heating system, a system based solely on the employment of a heat pump, and a system which uses a fuel-fired heater in addition to a heat pump (dual-source system). It is found that a heat-pump heating system is not economically competitive with an oil heating system. In the case of a dual-source system the costs are currently also higher than those for an oil heating system. However, there are a number of factors which, in the future, can change the competitive situation in favor of the dual-source system. G.R.

**A76-40366** Providing background information (Erarbeitung von Informationsmaterial). H.-G. Rumpf (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, May 1976, p. A 137-A 140. In German.

In connection with the general importance of the heat-pump as the basis for new developments in residential heating technology, it appears to be desirable to inform the public of the operational principles involved in heat-pump devices. Approaches are considered for providing the required information for the public in a form which can be understood by an average person who does not have a specialized education in science or engineering. G.R.

**A76-40367** Dual-source heating - Result of an opinion poll (Die bivalente Heizung im Meinungsspiegel - Ergebnisse einer Umfrage). W. Müller (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, May 1976, p. A 140, A 141. In German.

A description is given of the results of an opinion poll in which 340 persons in West Germany were asked questions related to aspects

of dual-source heating. The persons interviewed included architects, technicians for the installation of heating systems, representatives of residential-construction companies, members of the German parliamentary system, government officials, and journalists. It was found that 70% of the persons asked had never heard of the concept 'dual-source heating'. After the concept involved and its relation to other heating systems had been explained, a majority of the persons in the opinion poll were in favor of an introduction of the dual-source heating system. G.R.

**A76-40368** Product information on dual-source heat pump systems (Produktinformation für die bivalente Wärmepumpenheizung). H.-G. Ackermann (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau*, vol. 34, May 1976, p. A 141-A 143. In German.

Arguments in favor of an introduction of dual-source heat-pump systems are discussed, taking into account the necessity to save energy, the position of oil as a raw material for many applications, aspects of convenience, environmental compatibility, and costs of operation. Attention is given to suitable approaches to provide the public with information concerning the advantages of the new heating system. G.R.

**A76-40392** Energy futures - Wide open to change and choice. G. Leach. *Ambio*, vol. 5, no. 3, 1976, p. 108-116.

The relationship between energy consumption and wealth in developed and developing countries is examined. It is observed that within societies at similar stages of development, energy use and wealth (as measured by GNP) are only loosely connected; some developed countries with high standards of living - for example, Sweden - consume far less energy than others in spite of heavy industrialization and a cold climate. It is argued that the growth of GNP in developed countries can be leveled off without any decline in the standard of living, with decreased spending on energy-intensive goods and greater consumption of services and high value/low energy goods. The potential role of small-scale power production based on renewable resources is examined. It is pointed out that although low cost, high-efficiency systems have yet to be developed for the use of some renewable energy resources, the rapid implementation of low-cost, technically inelegant solutions may be highly desirable for some applications. C.K.D.

**A76-40400** Energy consumption for the prevention of atmospheric pollution (Consommation d'énergie pour la prévention de la pollution atmosphérique). J.-P. Detrie and R. Bouscaren (Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique, Paris, France). *Pollution Atmosphérique*, vol. 18, Jan.-Mar. 1976, p. 17-22. In French.

The energy consumption involved in the application of different air purification systems, including hydraulic, mechanical and electrical devices for the removal of aerosols, is analyzed. The cost of these systems in terms of energy consumed per unit of gas purified is estimated for a variety of industrial applications: urban waste treatment, steel production, oil refining, cement production, plaster production. It is estimated that the energy consumed for the prevention of air pollution in France represents a maximum of 0.5 percent of the total energy consumption for industry. C.K.D.

**A76-40426** Fuels for transportation. *Automotive Engineering*, vol. 84, Jan. 1976, p. 30-33.

The depletion of oil reserves makes the development of alternative sources of transportation fuels, such as oil shales, coal, and tar sand, essential. The raw material characteristics and disposable solids for a 100,000 barrel-per-day refinery using oil, coal, shale, and tar sands feed stocks are compared. The technological difficulties confronted in the location and development of crude oil substitutes makes vigorous efforts to increase the efficiency with which the refined products can be used necessary. The design of engines capable of operation on fuels with widely varying parameters should be a high research and development priority. C.K.D.

**A76-40427** Degasification of coalbeds - A commercial source of pipeline gas. M. Deul and A. G. Kim (U.S. Bureau of Mines, Pittsburgh Mining and Safety Research Center, Pittsburgh, Pa.). *American Gas Association Monthly*, vol. 58, May 1976, p. 7-9. 16 refs.

Coalbeds in the United States contain an estimated 300 trillion cubic feet of high-Btu gas, similar in composition and heating value to natural gas. The amount of gas in individual coalbeds can be accurately determined by measuring the gas contained in a core sample. Several methods are currently available for draining commercial quantities of gas from coalbeds, including horizontal boreholes from shaft bottoms, gob degasification, and vertical borehole hydraulic stimulation. Since the gas contained in coalbeds typically lies at depths of about 1000 feet, capital investment required for the development of these reserves will be lower than that required for tapping deeper natural gas reserves. The resulting product requires no remedial treatment for use as fuel or feedstock gas. Data on the composition and heating value of gas removed from a number of different coalbeds are given. C.K.D.

**A76-40429** Power from the sea. M. Swann. *Environment*, vol. 18, May 1976, p. 25-31. 10 refs.

The feasibility of sea thermal power systems exploiting the temperature difference between water at the surface and in the depths of tropical seas is examined. It has been estimated that the cost of electricity from sea thermal plants based on projected 1985 prices may be as low as 25 mills/kW hr, in contrast with about 37 mills/kW hr for nuclear power plants and about 44 mills/kW hr for coal-fired plants. Predicted capital costs for sea thermal plants range from \$1400 to \$1700/kW; sea thermal power will become commercially attractive if this figure can be reduced to about \$1000/kW. Critical technologies include improved heat exchangers and anti-corrosion treatments. Plants could be mass-produced at shipyards and towed to their working sites. Suggested products include oxygen, hydrogen, nitrogen, ammonia, carbon dioxide, methanol, and fresh water. C.K.D.

**A76-40430** Storing the sun. J. McCaull. *Environment*, vol. 18, June 1976, p. 9-15.

Energy storage technologies currently in competition for the limited portion of the Energy Research and Development Agency budget allocation for the investigation of wind and solar energy systems are examined. Among the storage systems considered are the lead-acid battery, advanced aqueous batteries, advanced alkali metal-sulfur batteries, hydrogen, thermal energy storage using liquid metal or molten salts, flywheels, hydro storage, compressed air systems, and superconducting magnets. The present state of development of each of these technologies is discussed, and estimates of their storage efficiency, energy density, and costs per kilowatt-hour of storage capacity and kilowatt of power rating are presented. C.K.D.

**A76-40431** Using the sun to heat, cool and cook at the University of Florida Solar Research Residence. E. A. Farber, C. A. Morrison, and H. A. Ingle (Florida, University, Gainesville, Fla.). *Building Systems Design*, vol. 73, Dec.-Jan. 1976, p. 3-7. 11 refs.

**A76-40432** Solar powered tracking device. C. A. Morrison, E. A. Farber, H. A. Ingle, and D. B. Wiggins (Florida, University, Gainesville, Fla.). *Building Systems Design*, vol. 73, Dec.-Jan. 1976, p. 7-9.

The paper describes the design and operation of a device for tracking the traverse of the sun across the sky, to be used in conjunction with a solar concentrator to ensure maximum solar energy collection. The tracking device consists of two solar energy sensors positioned on opposite sides of a parabolic concentrator which faces south and rotates about the north-south axis. These sensors can be positioned in such a way as to have an equal amount of exposure to the sun's incoming rays. Since the sensors are partially filled with a heat sensitive fluid, the pressure within them will be



dependent on the amount of solar energy absorbed by the surface of the sensor. An imbalance of temperature and pressure will occur when the concentrator varies from a position which is perpendicular to the incoming sun's rays. The movement of the mechanism will be such as to cause the concentrator to return to its desired orientation, regardless of the direction of misalignment. B.J.

**A76-40433**      **Cities as energy systems.** L. S. Windheim and R. R. Wodder. *Building Systems Design*, vol. 73, Feb.-Mar. 1976, p. 9-30. 14 refs.

The city is considered as an energy system from the points of view of city scale, landplans (defined as the systematized combinations of land use areas, transportation modes, utility service networks and energy supply generating and waste disposal systems), the failure of traditional planning, and urban energy patterns. Three approaches to urban energy planning are examined: (1) locational sensitive planning, (2) buildings as energy structures (better buildings design and the development of a figure of merit), and (3) multiuse activity centers (a modular integrated utility system and solar energy utilization). B.J.

**A76-40434 #**      **Focus on renewable energy in New Zealand.** R. E. Chilcott (Lincoln College, Canterbury, New Zealand). *New Zealand Energy Journal*, vol. 49, Apr. 25, 1976, p. 48-53. 25 refs.

Following a discussion of the flow of radiant energy in the biosphere, means of using solar energy and other renewable energy sources to supply the energy needs of advanced countries are considered, with particular reference to the availability of these potential energy sources in New Zealand. It is estimated that about half of the total domestic hot water consumed in New Zealand should be heated by solar energy. Some results indicate that production of ethyl alcohol from vegetable sources may be feasible; however, the extensive land area required must be considered. The average annual wind-electric energy available in New Zealand is about 0.1% of the annual average solar energy incident on the horizontal plane. Small windmills have been in widespread use for stock watering. A national wind energy resource survey is under way. C.K.D.

**A76-40435**      **Cathodic casing protection using solar panels.** C. M. Wylie, Jr. (Cities Service Oil Co., Oklahoma City, Okla.). *Petroleum Engineers*, vol. 48, July 1976, p. 21, 22, 24, 28.

A pilot system using solar cell panels for electrocorrosion protection of cathodic casings, installed on 11 well casings in August 1975, and consisting of 10 impressed-type groundbeds using solar panels and one sacrificial-type groundbed, is studied for effectiveness and expediting a combination of cathodic protection and solar cell technologies. The well casings require 1-2 amp to achieve cathodic protection. Soil resistivity problems, records to be logged, batteries for the solar panels, and groundbed load resistances are discussed. Solar cells are shown to be still too expensive for this application on a wide scale, but the pilot project results are judged a 'remarkable breakthrough', and solar cells could be used for the purpose in applications where current requirements are low (well below 10 amp). R.D.V.

**A76-40438**      **Alternative energy sources for the UK.** J. K. Dawson (Atomic Energy Research Establishment, Energy Technology Support Unit, Harwell, Oxon, England). *Atom*, Jan. 1976, p. 11-20. 5 refs.

The paper presents forecasts concerning alternative energy sources in the United Kingdom. These are alternative sources of heat - solar and geothermal energy, and alternative sources of electricity - wind, tides, and waves. A tentative judgment of the potential contribution of alternative sources to UK energy supplies in the year 2000 is presented. B.J.

**A76-40439 #**      **Nuclear power - The achievements, the problems and the myths /Melchett Lecture/.** J. Hill (Atomic Energy Research Establishment, Harwell, Berks., England). *Atom*, Feb. 1976, p. 34-45.

Advantages and disadvantages, costs, environmental impact, and energy yields of rival forms of energy generation are compared. Winds, tidal forces, ocean waves, geothermal sources, solar energy, hydroelectric sources, fossil fuels, and nuclear fission (but not fusion) are compared, with attention to costs and materials needed for structures adequate for large-scale exploitation of the less common natural sources. Nuclear burning is compared to coal burning. The comparative costs of nuclear fission-generated energy and energy generated from fossil fuels are discussed, with mention of the decline in fossil fuel prices in the 1960s and their rise in the '70s. The effect of age distribution of populations on energy demands in the future, sources of radioactivity, and health and accident records of various energy industries are considered. R.D.V.

**A76-40440**      **Observations on federal energy research and development - December 1974.** A. M. Weinberg (Oak Ridge Associated Universities, Inc., Oak Ridge, Tenn.) and C. C. Burwell (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Energy (UK)*, vol. 1, Mar. 1976, p. 3-9.

The paper recommends some federal energy research and development and related institutional changes that should be undertaken in response to events that have occurred since November 1973. Energy research policy and priorities are discussed with emphasis on the following: advanced methods of oil and gas recovery, technology to produce oil and gas from coal and oil shale, technologies that use energy efficiently, energy technologies independent of fossil fuel resources (breeder, fusion, solar, geothermal). Environmental issues are considered, including the estab-

**A76-40441**      **Priorities of energy research and development.** G. C. Werth, W. J. Ramsey, B. Rubin, R. L. Cooper, E. A. Green, and C. J. Anderson (California, University, Livermore, Calif.). *Energy (UK)*, vol. 1, Mar. 1976, p. 11-23. 23 refs. Contract No. W-7405-eng-48.

An analysis of national research and development priorities indicates that transportation is the most critical need. Four major points are covered: (1) transportation is essential and the automobile is the major mode of choice; (2) transportation is almost totally dependent upon oil, although domestic supplies are inadequate and foreign supplies are not assured; (3) unlike other markets, such as industrial, residential and commercial, competitive alternatives for the transportation market do not exist and must be developed; and (4) there are promising Research and Development possibilities for alternate fuels and vehicles but they are inadequately funded. (Author)

**A76-40442**      **Construction of nuclear reactors to obtain desired electricity-generating capacity.** S. S. Penner (California, University, La Jolla, Calif.). *Energy (UK)*, vol. 1, Mar. 1976, p. 45-51. 6 refs.

Schedules for nuclear-reactor development may be determined for any desired electricity-generating capacity. Net-energy ratios for nuclear-energy production from LWRs (light-water-moderated reactors) using high-grade ore are sufficiently favorably to allow construction of reactor scenarios that imply large savings in fossil-fuel resources during predetermined periods of time. (Author)

**A76-40443**      **Energy from agriculture - The most economic method of large scale solar energy conversion.** J. A. Alich, Jr. and R. E. Inman (Stanford Research Institute, Menlo Park, Calif.). *Energy (UK)*, vol. 1, Mar. 1976, p. 53-61.

The economics of terrestrial growth of vegetation for its energy content is far more favorable than other more technically sophisticated methods of large-scale solar energy conversion - mirrors, photovoltaics, etc. This paper summarizes our view of what might be

attainable in biomass production, hoping, thereby, to stimulate interest in the concept. The types of vegetation best suited for an intensive energy plantation, as well as vegetation selection criteria, will be discussed. The type and availability of land for growing energy crops on a conceptual terrestrial plantation, as well as the logistics and economics, are discussed. An energy budget for plant-material production and harvesting for the conceptual plantation is developed. A technoeconomic comparison of firing the crops directly for electric power generation with conversion to clean fuel gas (methane or low-Btu gas) either at the farm site or at selected markets is made. (Author)

**A76-40444 Preliminary design and economic analysis of solar-energy systems for heating and cooling of buildings.** F. Kreith (Colorado, University; Environmental Consulting Services, Inc., Boulder, Colo.) and J. F. Kreider (Environmental Consulting Services, Inc., Boulder, Colo.). *Energy* (UK), vol. 1, Mar. 1976, p. 63-76. 12 refs.

An overview is presented of the current state of the art of solar energy system design for the heating and cooling of buildings. Various solar systems are considered, including one with air as the working fluid and a rock bed thermal storage bin, and another with water as the working fluid, a water thermal storage tank, and an Li-Br absorption refrigerator. An economic analysis is carried out on solar systems for buildings, with a comparison of rock and water storage costs, and a discussion of annual costs for various solar systems. Some design features are considered, including architecture and esthetics, site characteristics and thermal and mechanical design. B.J.

**A76-40445 An evaluation of in situ coal gasification.** J. C. Fair, O. A. Larson, and H. H. Hasiba (Gulf Research and Development Co., Pittsburgh, Pa.). (*American Nuclear Society, Winter Meeting, San Francisco, Calif., Nov. 16-21, 1975.*) *Energy* (UK), vol. 1, Mar. 1976, p. 77-94. 17 refs.

The paper considers the orientation economics and some market aspects relating to a commercial extrapolation of a thin-seam in situ coal gasification scheme. The analysis attempts to determine produced gas cost for a commercial application of the forward gasification of coal from vertical boreholes using pneumatic pressure linking. Gas costs are computed as a function of well spacing, seam thickness, depth of cover, conversion sweep efficiency, product gas loss, and injection oxidant loss. A market analysis is performed on the basis of end-use options for the potentially evolving gas supply, and limitations concerning the transportation and consumption of each type of product are examined. B.J.

**A76-40446 Photoelectrochemical processes - The prevention of competitive anodic dissolution of the photon absorber in hydrogen production.** J. O. Bockris and K. Uosaki (South Australia, Flinders University, Bedford Park, Australia). *Energy* (UK), vol. 1, Mar. 1976, p. 95, 96.

Experiments were conducted on thin films of TiO<sub>2</sub> on substrates of CdS single crystal in NaOH solution under xenon lamp monochromatic illumination in order to determine the spectral response of the photocurrent produced. The spectral response of the TiO<sub>2</sub> on the CdS substrate, which approximates the response under solar energy conditions, was compared to the response of TiO<sub>2</sub> single crystals, and it was found that the energy conversion efficiency of the TiO<sub>2</sub> single crystal is about four times less than that of the TiO<sub>2</sub> on the CdS substrate. B.J.

**A76-40449 Expensive energy - Investigation concerning energy consumption and measures for the reduction of the consumption of primary energy in the Federal Republic (Teure Energie - Untersuchung des Energieverbrauches und Massnahmen zur Minderung des Primärenergieverbrauches in der Bundesrepublik).** A. Schneider. *Energie*, vol. 28, Jan. 1976, p. 1-12. 30 refs. In German.

Developments regarding the energy sector in the Federal Republic of Germany are examined, taking into account a pronounced reduction in the consumption of coal and mineral oil during the years 1974 and 1975. The reasons for the reduced energy consumption are studied. An investigation is conducted concerning the approaches which can be used to overcome problems related to a scarcity of energy expected in connection with the normalization of the economy. Attention is given to possibilities for saving energy in household and industry, relations between heat and power, the energy requirements of the transportation sector, and questions of energy transformation. G.R.

**A76-40451 ERDA's fossil R & D program - More out of the ground.** S. W. Gouse (ERDA, Washington, D.C.). *Energy*, vol. 1, Winter 1976, p. 20-23.

The major accomplishments of the ERDA fossil development program are new and improved technologies for conversion of coal to synthetic gas and liquids, for combustion of coal in a more efficient and environmentally acceptable manner, for transformation and refinement of shale oil, and the demonstration of petroleum and gas recovery techniques. The Fossil Energy Program includes eleven laboratory/process development units, nine pilot plants, and one demonstration plant. A table is presented listing the fossil fuel projects (high and low BTU gasification, direct combustion, advanced power systems, oil shale, etc.). B.J.

**A76-40452 \* ERDA-NASA wind energy project ready to involve users.** R. Thomas, R. Puthoff, J. Savino, and W. Johnson (NASA, Lewis Research Center, Cleveland, Ohio). *Energy*, vol. 1, Winter 1976, p. 27-30. 8 refs.

The NASA contribution to the Wind Energy Project is discussed. NASA is responsible for the following: (1) identification of cost-effective configurations and sizes of wind-conversion systems, (2) the development of technology needed to produce these systems, (3) the design of wind-conversion systems that are compatible with user requirements, particularly utility networks, and (4) technology transfer obtained from the program to stimulate rapid commercial application of wind systems. Various elements of the NASA program are outlined, including industry-built user operation, the evaluation phase, the proposed plan and schedule for site selection and user involvement, supporting research and technology (e.g., energy storage), and component and subsystem technology development. B.J.

**A76-40651 Fusion power - The transition from fundamental science to fusion reactor engineering.** R. F. Post (California, University, Livermore, Calif.). In: *EASCON '75; Electronics and Aerospace Systems Convention*, Washington, D.C., September 29-October 1, 1975, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 43-A to 43-K.

The basics of nuclear fusion are reviewed, with emphasis on fusion reactions. Quantitative requirements for fusion power - the Lawson criterion and the problems of plasma pressure and fusion power density - are discussed. Certain scientific, technological and engineering issues concerning controlled fusion are considered, in reference to the Tokamak, theta-pinch, mirror-machine, and stellarator approaches. B.J.

**A76-40805 The Seventh Annual Fairey Lecture - The better conservation of liquid fuels for mobile use.** J. H. Pitchford (Ricardo and Co., Engineers /1927/, Ltd., Shoreham-by-Sea, Sussex, England). *Journal of Sound and Vibration*, vol. 47, Aug. 8, 1976, p. 371-385.

The conservation of liquid fuel for automotive use is discussed. It is shown that the conventional four-cycle gasoline engine offers little hope for further improvement in fuel efficiency and that the Diesel engine is the most efficient internal-combustion engine currently available. Advantages and disadvantages relative to the

conventional gasoline engine are summarized for lean-mixture and stratified-charge spark-ignition engines, regular Diesels, low-compression spark-assisted Diesels, the Stirling cycle, the Rankine cycle, gas turbines (other than aircraft), and the Wankel engine. It is concluded that Diesel engines are the best alternative to conventional gasoline engines. Turbocharging and better matching of engines and transmissions are suggested as means of improving the 'fuel-to-wheel' efficiency of automotive engines. F.G.M.

**A76-40970 # The resources of hydrocarbon crude (O resursakh uglevodorodnogo syr'ia).** Ia. G. Sorkin (Visskh Khimiko-Tekhnologicheskii Institut, Sofia, Bulgaria). *Khimiia i Tekhnologiiia Toplivi Masel*, no. 7, 1976, p. 25-27. In Russian.

The amount of volatile hydrocarbons which can be separated from a given crude depends on a wide variety of factors, including parameters of the separation process (temperature, pressure and others) and characteristics of the individual crude (density, vapor pressure of components). With proper knowledge of the characteristics of the crude, the separation process can be modified to permit extraction of the largest possible portion of the lighter hydrocarbons, which would otherwise be lost by volatilization during storage and transportation. The widespread practice of evaluating the amount of gas available from a crude in terms of the working gas factor - the volume of gas which can be separated under ambient conditions - has a number of serious shortcomings which lead to underestimates of the extractable gas. It is urged that the development of an accurate technique for assessing gas resources from crudes be given high priority to prevent the waste of recoverable volatile components. C.K.D.

**A76-41046 The Billings bus - Total hydrogen operation.** *Automotive Engineering*, vol. 84, Aug. 1976, p. 50, 51.

Following a review of the principal advantages and limitations of hydrogen as an alternative fuel, the major design features of a hydrogen-powered minibus are presented. The fuel is stored in the form of iron-titanium hydride; enough fuel for about four hours of operation can be accommodated. Engine exhaust is routed through heat exchangers to provide the necessary heat for dissociation of the hydride. The carburetor, compression ratio, and ignition system of the power unit were modified for conversion to hydrogen. The bus, which is essentially pollution-free, is in experimental service along a 13-mile loop connecting Provo and Orem, Utah. C.K.D.

**A76-41101 \* Nationwide assessment of potential output from wind-powered generators.** C. G. Justus, W. R. Hargraves, and A. Yalcin (Georgia Institute of Technology, Atlanta, Ga.). *Journal of Applied Meteorology*, vol. 15, July 1976, p. 673-678. 9 refs. NSF Grant No. GAER-75-00547; Contract No. NAS3-17827.

A method for computing the actual expected power for a wind-powered generator from a given observed speed distribution is described and applied to estimate the potential output for different locations in the continental U.S. A contour map of generator capacity factor values (fraction of the rated output realizable) is obtained for wind-powered generator systems with a cut-in speed of 3.6 m/sec and a rated speed of 8.0 m/sec, and for a unit with hypothetical values for the 1 MW class (cut-in speed, 6.7 m/sec; rated speed, 13.4 m/sec). Results indicate that in the central U.S. and in certain areas of the New England coast at a height of 61 m, over 60% of the rated output power could be obtained on an annual average. In these areas capacity factors of over 20% could be obtained with the 1MW system. C.K.D.

**A76-41114 Operating experience with bulb units at the Rance tidal power plant and other French hydro-power sites.** H. André (Electricité de France, Paris, France). (*Institute of Electrical and Electronics Engineers, Winter Meeting and Tesla Symposium, New York, N.Y., Jan. 25-30, 1976.*) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-95, July-Aug. 1976, p. 1038-1044. 6 refs.

The development and performance of large bulb power units in France since 1957 are reviewed. A bulb unit is a hydroelectric power unit installed in a duct with its centerline coinciding with the flow axis. Design problems encountered in individual components of the Rance tidal power plant on the French Channel coast, which was designed for a net maximum output of 544 MWh, are discussed in detail. Special attention is given to design constraints imposed by the salinity of the water, high heat flux, and sharp temperature gradients. The performance of bulb units is compared with that of Kaplan units. C.K.D.

**A76-41139 Coal research. I - Is the program moving ahead.** A. L. Hammond. *Science*, vol. 193, Aug. 20, 1976, p. 665-667, 704.

The current status of Energy Research and Development Administration programs in coal research is discussed. Particular attention is given to the problem of striking an equitable scheme for financial risk sharing which will encourage the participation of private industry in the implementation of pilot plants for the demonstration of coal liquefaction and gasification. The status of proposed legislation restricting the participation of the oil industry in development of coal resources is examined. C.K.D.

**A76-41251 Commercial plant design for coal hydrocarbonization.** E. J. Ferretti (Dravo Corp., Pittsburgh, Pa.). *Coal Mining and Processing*, vol. 13, Aug. 1976, p. 60-63, 72, 73.

Preliminary results of design studies for a full-scale commercial plant using the Coalcon process for coal hydrocarbonization are outlined. The process is noncatalytic and based on a dry, fluid bed hydrocarbonization reaction with no solids/liquid separation step. Products are a high-Btu gas and a clean liquid fuel. Economic analyses and studies of site characteristics and coal supply factors have led to the selection of a 50,000 tons per day plant size, with production divided between two identical lines of 25,000 tons per day each. It is estimated that 34 such plants could supply about 12% of the current U.S. consumption of pipeline quality gas and enough heavy fuel oil to replace the foreign oil requirements of utility boilers in the eastern half of the U.S. Construction of a demonstration plant will begin in 1977. C.K.D.

**A76-41297 The project Independence construction program - Resource impacts.** C. W. Bullard, III and D. A. Pilati (Illinois, University, Urbana, Ill.). *Energy (UK)*, vol. 1, June 1976, p. 123-131. 19 refs.

This paper evaluates the total (direct and indirect) construction requirements for the energy program proposed in the President's 1975 State of the Union Message. Using a linear model of the U.S. economic system, the total material, energy, manpower, and capital requirements are evaluated. It is shown that indirect requirements for material and manpower exceed direct inputs in most cases, so focusing on direct requirements alone can lead to serious underestimates in resource requirements. Since the proposed program involves an acceleration of capital investment in the energy sector, the impact of diverting these funds from other activities is also discussed. (Author)

**A76-41298 Photoproduction of hydrogen - Potential dependence of the quantum efficiency as a function of wavelength.** J. O. Bockris and K. Uosaki (South Australia, Flinders University, Bedford Park, Australia). *Energy (UK)*, vol. 1, June 1976, p. 143-145.

An experiment was designed to examine the possibilities of direct solar energy conversion to hydrogen in an electrochemical cell. The quantum efficiencies of photoelectrochemical oxygen evolution on reduced NaOH were measured as a function of electrode potential and photon energy over the range 3.2-4.0 eV. Maxima in the relation of quantum efficiency to wavelength over the potential range -0.4 to 1.25 V were observed to shift towards lower photon energies as the potential became more positive. B.J.

**A76-41299** An investigation of the technical and economical feasibility of using low temperature geothermal sources in Colorado. L. W. Nannen, F. Kreith, and R. E. West (Colorado, University, Boulder, Colo.). *Energy* (UK), vol. 1, June 1976, p. 179-209; Appendices, p. 209-216. 45 refs. Research supported by the Colorado Energy Research Institute.

A preliminary feasibility study of utilizing low temperature geothermal sources in Colorado to heat buildings has been completed. It is concluded that the technology for using geothermal sources to heat building exists and that the cost of heat will be between \$2 and \$5 per million Btu delivered. Although geothermal heating is more expensive than heating with natural gas at current prices, it is considerably less expensive than heating by means of current solar thermal conversion methods. It is, therefore, recommended that an exploratory well be drilled in a place such as Glenwood Springs, Colorado, to define the thermal, chemical, and geological characteristics of a geothermal source in detail as a first step toward utilization of geothermal energy on a commercial scale in Colorado. (Author)

**A76-41319** How much energy and material from waste and biomass. *Energy*, vol. 1, Spring-Summer 1976, p. 9-13.

It is estimated that the 570-800 million tons of dry combustible solid waste discarded annually by municipalities, agriculture, and industries represents an energy loss of about 12% of total U.S. energy requirements. In addition, a substantial percentage of current natural gas needs could be supplied by conversion from biomass. A survey is presented of combustion, pyrolysis, and bioconversion processes for converting non-coal solid materials to energy. Brief descriptions of projects presently under way for the utilization of urban-industrial and agricultural-forestry wastes are given, together with examples of fresh water and ocean farming. C.K.D.

**A76-41320** Top the 40% efficiency barrier. G. N. Hatopoulos (Thermo Electron Corp., Waltham, Mass.). *Energy*, vol. 1, Spring-Summer 1976, p. 26-28.

The basic principles of thermionic energy conversion, in which electricity is produced directly from heat by evaporating electrons from a hot metal surface, are reviewed. The evolution of thermionic conversion technology is outlined. Current research indicates that the implementation of thermionic 'topping' to convert part of the high-temperature (between 1000 and 3000 F) heat energy into electricity before the balance of the heat is utilized could improve the efficiency of steam power plants to over 50%. Equilibrium work functions less than 1.2 eV at substrate temperatures up to 670 K have been obtained reproducibly. Current research and development is directed toward reducing ionization and plasma losses. Possible applications of thermionic converters are considered. C.K.D.

**A76-41365** # Electric street transportation and its contribution to the conservation of scarce fossil hydrocarbons (Elektrischer Strassenverkehr und sein Beitrag zur Einsparung knapper fossiler Kohlenwasserstoffe). H.-J. Budde (Gesellschaft für elektrischen Strassenverkehr mbH, Düsseldorf, West Germany). *Energie*, vol. 28, June-July 1976, p. 167-171. 25 refs. In German.

After a discussion of the energy crisis in industrial society, the article examines the possibilities of utilizing electric power sources in urban surface transportation, in an effort to conserve fossil fuels. The feasibility in the near future of electric-battery-powered surface vehicles (electric automobiles and buses of different size and propulsive power) is investigated. The efficiency of several hydrocarbon fuels is compared with that of electric propulsion systems for urban transportation. B.J.

**A76-41366** # Liquid hydrocarbons from coal - State of the art (Flüssige Kohlenwasserstoffe aus Kohle - Stand der Entwicklung). H. Bachl. *Energie*, vol. 28, June-July 1976, p. 172-177. 17 refs. In German.

The article describes a multistage process of coal treatment, where the final product is either a liquid or gaseous hydrocarbon.

The process begins with water vapor dissociation to obtain hydrogen followed by a hydrogen purification process. Hydrogenized gasification is followed by fractional distillation (with a thermal process applied for energy conservation) with the aid of a centrifugal machine. The final products are liquid hydrocarbons (the useful energy source, in this case) and gaseous hydrocarbons. Other applications of the centrifugal machine are detailed (e.g., ammonia synthesis, methanol synthesis). B.J.

**A76-41367** # State of the art and future development of heat storage technology in the German Federal Republic (Stand und künftige Entwicklung der Wärmespeichertechnik in der Bundesrepublik Deutschland). M. Wieler and U. Kaier (Kraftanlage AG, Heidelberg, West Germany). *Energie*, vol. 28, June-July 1976, p. 183-187. 23 refs. In German.

The operational problems and costs of past and present-day heat storage devices are discussed. New storage devices and techniques, both short term (pressureless devices, pipe-grid devices, devices for solar energy storage, and lightweight storage structures) and long term (pressureless cylindrical tanks, and techniques for utilizing the ocean, the earth interior and surface water for heat storage) are examined, together with their operational problems. The costs of the new heat storage technologies are considered, along with industrial production limitations of heat storage devices. B.J.

**A76-41368** # Reactors and the environment (Reaktoren und Umwelt). H. Hörning. *Energie*, vol. 28, June-July 1976, p. 194-202. 20 refs. In German.

The ways in which individuals can be subjected to nuclear pollution during the normal operation and the malfunctioning of nuclear power plants are considered. Radiation protection regulations stipulating maximum dosages to which an individual in a nuclear power plant can be subjected are examined. Natural and man-made sources of radiation are discussed, together with their effects on man. The relation between dosage and biological effects is studied. The deleterious effects of such substances as tritium, Kr-85, and plutonium are examined. The problem of radioactive wastes is considered, along with the problem of reactor protection against malfunctions. The polluting intensity of nuclear power plants is compared with that of conventional (fossil fuel) power plants. B.J.

**A76-41399** Prospects for geothermal energy on the island of Oahu, Hawaii. A. S. Furumoto (Hawaii, University, Honolulu, Hawaii). *Geothermal Energy*, vol. 4, June 1976, p. 7-9, 11-17, 19-22, 24, 25. 26 refs.

**A76-41400** Summary of 1975 geothermal drilling, western United States. J. L. Smith and J. S. Matlick (Republic Geothermal, Inc., Santa Fe Springs, Calif.). *Geothermal Energy*, vol. 4, June 1976, p. 28-31.

**A76-41401** Solar heating in France. B. Carter. *Building Services Engineer*, vol. 44, Aug. 1976, p. A19-A24.

The operation of eight solar heating installations in private dwellings in the south of France is described. All of the installations discussed utilize flat plate collectors. The storage cylinders are of the indirect type, with a coil in the bottom through which solar heated water is circulated. Installations with 4 sq m collectors and 300 liters storage can provide domestic hot water for small families from May to October in the south of France; it is concluded that the use of solar energy to supply domestic hot water would be feasible in England during the summer months. C.K.D.

**A76-41404** \* Don't waste waterweeds. B. Wolverson and R. C. McDonald (NASA, Marshall Space Flight Center, National Space Technology Laboratories, Bay St. Louis, Miss.). *New Scientist*, vol. 71, Aug. 12, 1976, p. 318-320.

Experiments carried out at the NASA National Space Technology Laboratories indicate that water hyacinths can absorb organic chemicals, heavy metals, nutrients, and other materials from waste water while producing large quantities of biomass, which can be used to produce a gas containing 60-80% methane. When grown in sewage free of toxic materials, the biomass can be used as a potential source of fertilizer or animal feed supplements. The use of hot water from nuclear power plants to grow water hyacinths during the winter months is particularly attractive, since the hyacinths could act as an added safety filtration system for the removal of radioactive elements. C.K.D.

**A76-41493 #** Guidance, energy management, and control of a fixed-impulse solid-rocket vehicle during orbit transfer. J. T. Patha (Boeing Aerospace Co., Seattle, Wash.) and R. K. McGehee (Boeing Computer Services, Inc., Seattle, Wash.). In: Guidance and Control Conference, San Diego, Calif., August 16-18, 1976, Proceedings. Conference sponsored by the American Institute of Aeronautics and Astronautics, New York, American Institute of Aeronautics and Astronautics, Inc., 1976. 13 p. (AIAA 76-1920)

Techniques and methods are developed to guide a solid-rocket motor (SRM) orbital vehicle to a high degree of accuracy. The SRM has no commanded thrust termination. An energy-management technique coupled with closed-loop guidance, a reaction control system, and SRM thrust vector control produces trajectory accuracies comparable to those produced by a liquid-rocket engine that has thrust termination and restart capability. The Boeing Interim Upper Stage (IUS) geosynchronous mission vehicle is a specific example used to demonstrate the guidance and control concepts developed in this research. The IUS comprises a family of vehicles which deliver space shuttle payloads to designated earth orbits and planetary trajectories. (Author)

**A76-41525** Transfer matrix for analysis of composite flywheels. R. H. Toland (California, University, Livermore, Calif.) and J. Alper (Drexel University, Philadelphia, Pa.). *Journal of Composite Materials*, vol. 10, July 1976, p. 258-261. 9 refs.

A plane stress solution for a steady-state rotating disk with orthotropic elastic moduli and thermal expansion coefficients is cast in the transfer matrix form. The stress function is solved to arrive at a solution for radial stresses, hoop stresses, and radial displacement. The study is relevant to energy storage systems utilizing flywheels made of high-performance composites (reinforced with glass fibers or Kevlar fibers). R.D.V.

**A76-41601** Coal research. II - Gasification faces an uncertain future. A. L. Hammond. *Science*, vol. 193, Aug. 27, 1976, p. 750-753.

Four coal gasification processes developed in the 1960s as alternatives to the Lurgi and Koppers-Totzek processes - Carbon Dioxide Acceptor, Hygas, Bi-gas and Synthane - have been or are being evaluated in pilot plants. These processes are outlined, and their technological and economic difficulties are identified. Two processes presently under consideration for demonstration plants, a slagging Lurgi process and the Cogas composite process, are described, together with the Texaco process. Problems in the development of coal gasification technology resulting from the 50-50 sharing of costs by government and industry are discussed. C.K.D.

**A76-41625 #** Development prospects and technical problems of nuclear fusion (Entwicklungsaussichten und technische Problematik der Kernfusion). K. F. Alexander (Deutsche Akademie der Wissenschaften, Zentralinstitut für Elektronenphysik, Berlin, East Germany). *Energietechnik*, vol. 26, May 1976, p. 189-193. In German.

The basic physical relations which are involved in the processes of thermonuclear energy generation are examined, taking into account the containment of the fusion plasma, the conditions for a

self-maintaining fusion reaction, and the theta pinch. Particular attention is given to the development of fusion reactors which utilize the Tokamak design concept. A description is given of the various stages of fusion reactor development. The significance of nuclear fusion for the power economy is examined and advantages of fusion processes in comparison to nuclear fission reactors are pointed out. G.R.

**A76-41731** Technical-economic calculations in the case of constant energy sources. R. B. Salieva (Tashkentskii Institut Sviazi, Tashkent, Uzbek SSR). (*Geliotekhnika*, no. 5, 1975, p. 52-57.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 42-45. 8 refs. Translation.

An economic analysis is conducted concerning the design, construction and utilization of solar power plants and wind power plants. Methods are presented for determining operational costs, for reducing them, and for calculating the real cost of producing solar and wind energy. Criteria are presented for selecting cost-optimal output power. B.J.

**A76-41735** Degradation of the characteristics of a thin-film photovoltaic Cu/x/S-CdS cell. Kh. T. Akramov, G. Ia. Umarov, and T. M. Razykov (Tashkentskii Gosudarstvennyi Universitet, Tashkent, Uzbek SSR). (*Geliotekhnika*, no. 6, 1975, p. 8-11.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 78-80. 7 refs. Translation.

Results of experimental investigations of the performance of the thin-film heterojunction Cu/x/S-CdS for use in solar cells are reported. The base layer - CdS - was deposited by a gas-transport technique in a flow of H<sub>2</sub> on a molybdenum substrate. The p-layer of copper sulfide was obtained by immersing the CdS layer into an aqueous solution containing positive copper ions. The I-V, C-V, spectral and load characteristics of the thin-film specimens, prepared with and without heat treatment, and with an energy conversion efficiency of about 3%, were tested under close to solar radiation conditions in the course of 4000 hours. B.J.

**A76-41736** Operation of a thin silicon photoconverter under illumination on both sides. N. M. Bordina, T. M. Golovner, V. V. Zadde, A. K. Zaitseva, A. P. Landsman, and V. I. Strel'tsova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, no. 6, 1975, p. 12-19.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 81-86. Translation.

The paper studies the spectral distribution of the collection coefficient of a silicon solar cell illuminated at different times from the front and back sides. The dependence of the short-circuit current on cell-thickness is calculated during illumination from each of the two sides separately. It is shown that reduction in cell-thickness with the simultaneous elimination of carrier recombination on the back side does not worsen the volt-ampere characteristics of the cell during illumination from the front side and simultaneously increases the short-circuit current and the energy conversion efficiency during illumination from the back side. B.J.

**A76-41737** Gallium arsenide solar cells obtained by ion bombardment. A. A. Gavrilov, G. A. Kachurin, and L. S. Smirnov (Akademiia Nauk SSSR, Institut Fiziki Poluprovodnikov, Novosibirsk, USSR). (*Geliotekhnika*, no. 6, 1975, p. 20-24.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 87-89. 8 refs. Translation.

The characteristics of gallium arsenide solar cells, obtained by the implantation of cadmium and zinc ions into the n-region were studied. During implantation of cadmium ions, increased losses were observed from the cells due to the high layer-resistance of the p-region and to the near-surface recombination of generated carriers. The high recombinational losses are linked to the incomplete annealing of defects and to the small doping depth of the p-n junction. The small doping depth is conditioned by the relatively

small diffusion coefficient of the cadmium and the trapping of the additive in the dislocated layer. The implantation of zinc ions led to the increase of the conductivity of the p-layer and to the displacement of the region of the p-n junction further from the irradiated surface due to the high diffusion coefficient. As a result solar cells are obtained with characteristics analogous to those of diffusion junctions and with a high energy conversion efficiency (9.0 to 9.5% without the use of brightening filters). B.J.

**A76-41740** Graphoanalytic method of determining the shape and size of the reflecting surface of a heliostat. A. V. Vartanian, Ia. T. Shermazanian, and V. V. Arutiunian. (*Geliotekhnika*, no. 6, 1975, p. 36-45.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 99-106. 7 refs. Translation.

An economic analysis is conducted concerning the design, construction and utilization of solar power plants and wind power plants. Methods are presented for determining operational costs, for reducing them, and for calculating the real cost of producing solar and wind energy. Criteria are presented for selecting cost-optimal output power. B.J.

**A76-41741** Concentrating power of reflecting systems in solar energy stations - The influence of geometric factors. D. I. Tepliakov and R. R. Aparisi (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). (*Geliotekhnika*, no. 6, 1975, p. 46-58.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 107-115. 13 refs. Translation.

The dependence of the collecting capacity of the mirror systems of paraboloid solar arrays on the geometry of the central receiver is investigated. The dependence of the mean collecting capacity of the array on the angular aperture of the collector is plotted for the cases of planar, conical, cylindrical, and spherical receivers. B.J.

**A76-41742** Fabrication and investigation of faceted film concentrators. O. Iu. Sobirov, A. M. Gafurov, S. N. Vil'kova, and R. A. Zakhidov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (*Geliotekhnika*, no. 6, 1975, p. 64-68.) *Applied Solar Energy*, vol. 11, no. 5-6, 1975, p. 120-122. Translation.

The paper describes a 3-meter foam-film faceted solar collector consisting of 7 parabolic reflectors each with a diameter of 95 cm, a coverage angle of 34 degrees, and a focal distance of 158 cm. A metallized PTFE film was used in the fabrication of the foam-film facets to be employed as reflecting surfaces. The film was subjected to forming at 170 C which eliminated residual stress and gave it a shape close to paraboloidal. The film was fixed with three layers of epoxy resin to preserve this shape. A system for tracking the visible image of the sun while rotating about the azimuthal and zenithal axes was used to measure the opto-energetic characteristics of the collector. B.J.

**A76-41757** Solar energy its status and prospects. D. Redfield (RCA Communications Research Laboratory, Princeton, N.J.). *RCA Engineer*, vol. 22, June-July 1976, p. 71-75. 15 refs.

The different subprograms encompassed by the National Plan for Solar Research and Development recently issued by the Energy Research and Development Administration (ERDA) are described briefly. The subprograms are at widely differing stages of development. Direct thermal applications are well advanced. The technologies for solar heating are nearing the point of commercial applicability and are expected to become increasingly economical as fuel costs rise and the cost per unit decreases. Of the solar electric applications currently under development, wind energy conversion

systems and solar photovoltaic conversion systems are the most advanced. Construction of a 5 MWth test facility for solar thermal energy conversion is under way, and it has been estimated that intermediate-load systems will be competitive with fossil fuel plants around 1990. Ocean thermal energy is in the earliest stages of development, with basic component and system designs as yet unresolved. Bioconversion to clean fuels has been successfully demonstrated using urban, agricultural, and animal wastes. The potential offered by solar energy is compared with that offered by other 'alternative' energy sources. It is urged that solar energy be given highest priority in national energy research and development programs. C.K.D.

**A76-41773** # Evolution of the satellite solar power station /SSPS/ concept. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Journal of Spacecraft and Rockets*, vol. 13, Sept. 1976, p. 573-576. 10 refs.

The evolution of the SSPS configuration as a result of technical and economic studies is reviewed. The advantages of converting solar energy via an SSPS in synchronous orbit are noted, and the superiority of microwave power conversion over photovoltaic conversion is demonstrated. The characteristics of the baseline SSPS configuration and the major aspects of space transportation, assembly, and maintenance are discussed. The economic viability of the SSPS is evaluated, and the three major phases of the SSPS development program are examined. V.P.

**A76-41791** Future energy sources. H. L. Berk, R. F. Post, J. Rinde (California, University, Livermore, Calif.), A. Laird (California, University, Berkeley, Calif.), J. Stanley (Stanford University, Stanford, Calif.), and H. Zullinger (Nuclear Semi-Conductor, Menlo Park, Calif.). In: Western Electronic Show and Convention, San Francisco, Calif., September 16-19, 1975, Technical Papers. (A76-41787 21-12) North Hollywood, Calif., Western Periodicals Co., 1975, p. 14/1 1-14/1 12. 10 refs.

Some of the energy resources and technologies available for the immediate and distant future are surveyed, with emphasis on technical considerations. The fields surveyed are fossil fuels (with energy flow patterns presented and costs and annual consumption figures tabulated), nuclear fission, geothermal energy, solar energy, controlled fusion, and laser fusion. B.J.

**A76-41799** Coal research. III - Liquefaction has far to go. A. L. Hammond. *Science*, vol. 193, Sept. 3, 1976, p. 873-875.

Liquefaction of coal in the true sense of that term is still an unattained goal. Existing commercial processes for converting coal to liquid fuels gasify the coal first and then synthesize a liquid product. They are inefficient, since they involve high temperatures and the breaking of all the carbon-carbon chemical bonds in the coal material before putting some of them back together again. More promising are methods in which coal is liquified directly or is refined to clean fuel under conditions much less extreme than those of gasification. Efforts in the U.S. are currently concentrated on the Solvent Refined Coal process, the H-coal process, and Donor Solvent process. The technical and economic aspects of these processes are discussed, and the key role played by the catalysts is noted. V.P.

**A76-42018** New orientations of the energy economy; Working Meeting, 18th, Universität Köln, Cologne, West Germany, April 17, 18, 1975, Reports and Discussion Contributions (Neuorientierungen der Energiewirtschaft; Arbeitstagung, 18th, Universität Köln, Cologne, West Germany, April 17, 18, 1975, Vorträge und Diskussionsbeiträge). Munich, R. Oldenbourg Verlag (Tagungsberichte des Energiewirtschaftlichen Instituts, No. 18), 1975. 234 p. \$7.20. In German.

The new situation with respect to the world petroleum market is examined, taking into account the effects of the higher oil prices on the economy. The objectives of an international cooperation in the energy sector and the approaches to be used in such a cooperation are considered. The role of government and economy in dealing with energy problems is investigated and the characteristics of energy-related research as a task for national and international cooperation are discussed. The requirements of power-system investment financing in relation to the capital market and taxation regulations are studied. Attention is also given to problems of long-term planning in the energy sector and suitable strategies for the enterprises of the energy economy in a structurally changed environment. G.R.

**A76-42095** The structure and operation of a long-range energy simulation model. C. E. Whittle, D. B. Reister, E. G. Silver (Institute for Energy Analysis, Oak Ridge, Tenn.), and J. F. Weinhold (ERDA, Washington, D.C.). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1245-1256. 16 refs.

A model is proposed for simulation of plausible U.S. energy supplies and demands for the last part of the 20th century and the first part of the 21st century. Demand functions are generated for each of the energy carriers - electricity, liquids, gases, and solids - through examination of the industrial, the residential and commercial, and the transportation demand sectors in terms of their component activities. Supply functions are generated independently for each of the energy carriers based on the best available data and estimates for the fossil fuels, uranium, hydroelectricity, geothermal heat, and solar energy, and on present knowledge and projections about extraction and conversion technology. A computer program for combining the independently generated supply and demand functions is developed, and the combined results are displayed in tabular and graphic form. An iterative matching process is discussed along with the limitations of the model. S.D.

**A76-42096** An energy model for Washington State. J. R. Albers and J. Black (Huxley College of Environmental Studies, Bellingham, Wash.). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1257-1272. 8 refs. Research supported by the Washington State House of Representatives.

The paper deals with the Washington State energy system, a computer model that has been developed of that system, and the various energy policy alternatives which are being simulated by means of the model. The model includes seasonal, environmental, and economic effects, and it is organized to reflect the ten basic stages of the Washington State energy system. The model describes the movement of each fuel type through the state energy system from extraction or importation through processing and distribution to end use. Graphic reports are generated at each step of the process. The consequences of various policy alternatives will be submitted to state agencies for their evaluation as part of the decision making process. S.D.

**A76-42097** The Wisconsin Regional Energy Model - A dynamic approach to regional energy analysis. W. K. Foell, J. W. Mitchell, and J. L. Pappas (Wisconsin, University, Madison, Wis.). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1273-1287. 17 refs. Research sponsored by the Upper Great Lakes Regional Commission and NSF.

The Wisconsin Regional Energy Model (WISE) combines an engineering and economic approach to model the State's energy system. WISE is essentially a massive computerized information system which describes energy demand, conversion, transport, and use, explicitly accounting for technological, economic, and environmental interactions. The WISE model has been employed to analyze

a variety of energy related problems for Wisconsin. Among the issues that have been examined are: (1) forecasts of future electricity demands for use in long-range generating capacity additions decisions; (2) energy conservation possibilities including appliance efficiency labeling and requirements, improved insulation and ventilation standards in state building codes, and policies aimed at promoting the use of more efficient passenger automobiles; and (3) the impact on the State of diversion of various quantities of natural gas. (Author)

**A76-42098** A two-level iterative model for estimating inter-fuel substitution effects. D. J. Behling, W. Marcuse, M. Swift, and R. G. Tessmer, Jr. (Brookhaven National Laboratory, Upton, N.Y.). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1328-1338. 10 refs. ERDA-supported research.

Fuel substitution effects are localized in a small submatrix by redefining sectoral energy use in terms of nonsubstitutable final energy products such as space heat and motive power. A combination of an optimization model of the national energy system with the Bullard-Sebald (1975) input-output model is described. This provides an analytical framework for evaluation of economy-wide impacts of future technological change due to resource substitution or introduction of new energy technologies. Solution techniques and the methodology for introducing new energy technologies are outlined. S.D.

**A76-42099** Preliminary study on international oil energy policies. R. Ohkuma (Nippon Mining Co., Ltd., Tokyo, Japan), T. Sumita (Century Research Center, Tokyo, Japan), and T. Utsumi (Japan GLOSAS Associations, Tokyo, Japan). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1371-1380. 16 refs.

Following a discussion of energy policies in most oil consuming countries since the oil embargo in 1973, the paper discusses the capabilities of a simulation model as an effective tool to decision making specialists for their understanding of the system, with dynamic formulation of simulation results regarding inter-relationships between energy and economic policies among many oil producing and consuming countries. The simulation model consists of three sectors: oil producing countries, oil allocation, and oil consuming countries. It is concluded that the developed oil consuming countries, which have utilized inexpensive oil as their main energy source to accelerate their industrialization, will never get rid of their oil dependency until the year 2000. It is quite possible that the oil producing countries will impose their oil producing and pricing policies on the oil consuming countries in order to establish a dominant status in the international monetary field for industrialization of their countries. S.D.

**A76-42100** Validation of a computer aided design model for solar heating and cooling of buildings. C. B. Winn, R. L. Craun, and G. R. Johnson (Colorado State University, Fort Collins, Colo.). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1427-1431.

A simulation model for dynamic performance evaluation of solar heated and/or cooled buildings is developed and tested, with particular reference to prediction of the performance of the solar heated and cooled laboratory at Colorado State University. The model is a performance analysis model which can be used for computer-aided design of solar heating and cooling systems for buildings. The program has the capability of using actual recorded weather data for a specified geographic location and includes a model of the enclosure for doing heat load and heat gain analysis. Comparisons of simulated temperatures versus actual temperatures for the storage tank and the enclosure are presented. S.D.

**A76-42101**      **Dynamic simulation of a solar heated and cooled building.** H. S. Murray and T. H. Kuckertz (California, University, Los Alamos, N. Mex.). In: Summer Computer Simulation Conference, San Francisco, Calif., July 21-23, 1975, Proceedings, Volume 2. Montvale, N.J., AFIPS Press, 1975, p. 1450-1457. 5 refs.

A dynamic model of the solar heated and cooled National Security and Resources Study Center is presented. The approach differs substantially from ordinary quasi-steady state simulations of building energy systems in which the building interior temperature is assumed constant for the purpose of calculating hourly system heat loads. Simulation of subsystems which have relatively short time constants is required for controls studies on the building heating and cooling system and for evaluation of energy conserving operating strategies. A hybrid computer implementation for the model is chosen. In this approach, one year of operation is examined in 7.3 minutes by scaling the equations to simulate one hour of real time in 0.05 sec of machine time. The model includes dynamic descriptions of a double-glazed flat plate solar collector system, the hot water energy storage system, an absorption water chiller, the heating, ventilating, and air conditioning system, and the building shell and interior. Actual data for ambient temperature, wind velocity, relative humidity, and solar flux (insolation) are used to force the model.

(Author)

**A76-42128**      **Environmental effects of energy production.** S. F. Singer (Virginia, University, Charlottesville, Va.). In: The changing global environment. Dordrecht, D. Reidel Publishing Co., 1975, p. 25-44. 36 refs.

Changes in per capita energy use and the types of fuels feeding it in this country and abroad since 1800 are examined. The environmental effects of combustion products of fossil fuels - in particular, sulfur compounds, nitrogen oxides, and carbon dioxide - are considered. Possible environmental effects of the use of fossil fuels are compared with those associated with nuclear energy. It is concluded that the major environmental hazard involved in the production and utilization of energy from either source is thermal pollution. The increased temperature of cooling water released into streams reduces the amount of dissolved oxygen and the capacity of the stream to assimilate organic wastes. The release of large amounts of waste heat into the atmosphere in increasing quantities may be expected to have an impact on convection patterns.

C.K.D.

**A76-42202 #**      **International legal implications of solar energy.** S. Gorove. In: Colloquium on the Law of Outer Space, 18th, Lisbon, Portugal, September 21-27, 1975, Proceedings.

Davis, Calif., University of California; South Hackensack, N.J., Fred B. Rothman and Co., 1976, p. 15-17. 5 refs.

The paper examines the legal implications of solar energy utilization from the point of view of space law (i.e., satellite solar energy conversion). The question whether there are any stipulations in the currently existing outer space agreements which would limit the utilization of solar energy is discussed. Provisions of the Outer Space Treaty of 1967 pertaining to this question and to the loss of life, injury or damage caused by solar energy utilization, and changes in the environment brought about by such utilization are considered.

B.J.

**A76-42372 #**      **The design and performance of solar-power satellites (Entwurf und Leistungsfähigkeit von Sonnenenergie-Satelliten).** D. Köhn, K. Jesche, J. Rath (Telefunken AG, Berlin, West Germany), D. Teichmann (Berlin, Technische Universität, Berlin, West Germany), and G. Wirths (Dornier-System GmbH, Friedrichshafen, West Germany). *American Astronautical Society and Deutsche Gesellschaft für Luft- und Raumfahrt, International Meeting on Utilization of Space Shuttle and Spacelab, Bonn, West Germany, June 2-4, 1976, Paper.* 13 p. 8 refs. In German.

An employment of satellite solar power stations has certain

advantages when compared to a use of terrestrial power stations based on the utilization of solar radiation. The advantages are related to the greater intensity and uniformity of solar radiation in space. A project for a solar power station based on thermoelectric energy conversion is considered. Solar power stations employing solar cells for a direct conversion of solar-radiation energy into electric energy are also discussed. Attention is given to problems which have to be solved for an implementation of the considered projects. An investigation of the economic aspects involved is also conducted, taking into account the possibilities provided by an introduction of advanced solar-cell production methods.

G.R.

**A76-42379 #**      **Potential for future space solar power systems.** R. H. Nansen (Boeing Aerospace Co., Seattle, Wash.). *American Astronautical Society and Deutsche Gesellschaft für Luft- und Raumfahrt, International Meeting on Utilization of Space Shuttle and Spacelab, Bonn, West Germany, June 2-4, 1976, Paper.* 24 p.

The concept of generating power in space and transmitting the power to the earth was studied by Boeing in 1972. In the present paper, the results of these studies are reviewed. The solar power satellite concept as an alternate source of energy is outlined. The requirements involved in establishing a power plant in space are discussed, with particular reference to the transportation of the satellite hardware to a low orbit, the orbital assembly, the orbital transfer of the assembled satellite, and the problem of devising an effective energy link to the earth surface. The main challenge is seen in the scope of the program and the size of the hardware to be built. The results of the study confirm the technical feasibility of the concept and its economic competitiveness with alternate future energy sources.

V.P.

**A76-42476**      **Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.** Conference sponsored by the Missouri Energy Council, University of Missouri, and Continental Oil Co. Edited by J. D. Morgan (Missouri, University, Rolla, Mo.). North Hollywood, Calif., Western Periodicals Co., 1976. 446 p. \$39.50.

Topics considered at the conference included energy management, wind and solar energy, chemical energy conversion, the economics of energy, nuclear energy and power, the energy environment, and mining and petroleum. Papers are presented on the feasibility of using the excess energy available from solar heating systems for electric power production, coal conversion processes, wind energy concentrators and centralized solar wind home heating. Also considered are the feasibility of osmotic power from the mixing of fresh water and sea water, methane production from plant matter, and methods for improving the thermal efficiency of spark ignition engines.

B.J.

**A76-42477**      **Solar assisted power systems.** A. G. Potter (Iowa State University of Science and Technology, Ames, Iowa). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 47-56. 12 refs.

The paper examines the feasibility of using the excess energy available from solar heating systems for electric power production so that power system peaking capacity and total fossil fuel consumption can be reduced. Two solar energy collection and conversion schemes are considered: for wind energy collection and subsequent electrical generation, a horizontal axis wind turbine with a threshold wind speed of 22.4 mph; and a Rankine cycle heat engine generator using freon as a working fluid and driven by excess heat from a flat plate solar collector. Possible solar energy storage technologies are considered, including storage batteries, pumped hydro, compressed air,



liquid ammonia, and liquid hydrogen systems. It is found that the liquid ammonia storage system is the best overall choice when pumped hydro or compressed air are not feasible. An energy cost analysis and economic analysis are performed on the solar assisted power system. B.J.

**A76-42478 Coal conversion technology.** K. A. Dollar (Du Pont de Nemours and Co., Inc., Wilmington, Del.) and H. A. Wiebe (Missouri, University, Rolla, Mo.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 65-76. 9 refs.

A structured comparison of coal conversion processes is presented in terms of operating costs and revenues, process efficiencies and qualitative desirability factors (sensitivity to product prices, public acceptance, labor requirements). Two types of conversion processes are considered: those for the production of synthetic natural gas pyrolysis, clean coke carbonizing and hydrogenating, and the Lurgi, Koppers-Totzek, Winkler, Hygas, CO<sub>2</sub> acceptor, Synthane, Bigas, Hydrane, Atgas, molten salt, steam-iron, methanation, and Toscoal processes; and those for the production of synthetic crude oil - the Bergius, Fischer-Tropsch, project gasoline, Synthoil, and Pamco processes. B.J.

**A76-42479 Wind energy concentrators.** J. L. Loth (West Virginia University, Morgantown, W. Va.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 93-107. 10 refs. NSF Grant No. AER-7500367-000.

This paper presents two alternatives to the shrouded propeller wind energy concentrator. Their operation is based on generating a low pressure area, with high local wind velocity, around the windmill rotor. The two types of wind energy concentrators considered are: (1) the 'obstruction type' concentrator where a vertical cylinder or vertical flat surface is used to produce high local velocities around two counter-rotating vertical axis rotors, and (2) the 'vortex type' concentrator where a horizontal vortex is generated by a vertical high lift wing of finite span. The high local wind kinetic energy inside the vortex is harnessed by a horizontal axis rotor. The performance parameters such as the power concentration ratio and the associated area ratio have been determined theoretically. Some preliminary experimental data are included. (Author)

**A76-42480 Centralized solar wind home heating.** R. Peterson and D. Cromack (Massachusetts, University, Amherst, Mass.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 108-115. 34 refs.

The paper discusses basic technical feasibility and energy resource availability considerations for achieving an integrated total coordinated thermal development (TCTD), which is a complex of energy conservative structures clustered with a centralized solar-wind heating system. Seasonal distribution of the solar-wind output was calculated, and the centralized solar-wind heating system is expected to meet about 88% of the space and water heating requirement. P.T.H.

**A76-42481 Small wind power machine for rural and farm use in the State of Missouri.** R. B. Oetting (Missouri, University, Rolla, Mo.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference

on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 116-120. 7 refs.

This paper describes work in progress to develop a prototype wind power generator for use by small farms, rural and isolated homes. It is anticipated that the wind power generator may supply power (1 to 10 kw) as base electric power (including energy storage), supplemental power, or in other forms (e.g. water pumping, nitrogen or hydrogen manufacture, and direct mechanical drive). The objective of this study is to produce a system(s) of high efficiency, low construction cost, and minimum maintenance requirement. Preliminary wind tunnel tests have been completed on several blade designs. A tower system is under construction on campus that will provide for the continuous testing of the full size prototype wind power generators. (Author)

**A76-42482 Osmo-power - Osmotic work; energy production from osmosis of fresh water/sea water systems.** H. H. G. Jellinek (Clarkson College of Technology, Potsdam, N.Y.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 121-134. 9 refs.

The paper discusses the feasibility of osmotic power - the extraction of energy by mixing fresh water (river water) with electrolyte solutions (sea water) through semipermeable membranes. Osmo-power can be based on the utilization of either kinetic energy - by locating a nozzle near the surface of an osmotic cell, with the liquid jet emerging from such a nozzle driving a turbine producing electrical energy, or potential energy - by raising the liquid by osmosis to a suitable height and letting it fall to zero height level, driving a turbine. Cost estimates indicate that the cost per kW hr of electrical energy from the osmotic process compares favorably with electrical energy from nuclear plants and even more favorably with electrical energy produced from fossil fuels. B.J.

**A76-42483 Energy from agriculture.** E. C. Clausen, D. L. Million, E. L. Park, and J. L. Gaddy (Missouri, University, Rolla, Mo.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 135-142.

The paper examines the feasibility of methane production from crops and crop residues by anaerobic digestion. An economic analysis indicates that this bioconversion process is economically attractive at today's fossil fuel prices. The methane production process is illustrated diagrammatically, and tables are presented with economic analyses of bioconversion of crop wastes in northwest Missouri and of bioconversion from hay. The available waste material (soybeans, corn, small grains, sorghum, and cotton) in Missouri and the Chillicothe area is considered. B.J.

**A76-42484 Lean burning spark-ignition engines - An overview.** J. A. Alic (Wichita State University, Wichita, Kan.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 143-168. 44 refs.

Ways of improving the thermal efficiency of spark ignition internal combustion automobile engines through fuel-lean combustion at part load are examined. The paper considers stratified charge engines (divided chamber and open chamber) and engines using alternate fuels (hydrogen, methanol, propane, and butane). The primary advantages of the engines examined have the same two

sources: lower combustion temperatures resulting from lean combustion, and less intake throttling. Lean-burning engines also have potentially good emissions characteristics because the excess air promotes complete combustion of hydrocarbons and carbon monoxide, while the lower temperatures result in reduced reaction rates for the formation of nitrogen oxides. B.J.

**A76-42486**      **Alternative approaches to energy modeling.** A. S. Cohen and K. W. Costello (Argonne National Laboratory, Argonne, Ill.). In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 211-219. 9 refs. ERDA-supported research.

The paper evaluates a number of models for the analysis of regional impacts of energy policies, which consider production and transportation costs, the location of reserves, and the demands for energy and nonenergy goods. The energy models, all of which consider more than one fuel and sector (i.e., residential, utility, etc.), are evaluated on the basis of three sets of criteria: model comprehensiveness, economic aspects of the model, and model capabilities (policy changes, technology changes). The following models were considered: the Battelle Columbus-EPA Energy Quality model, Baughman's Dynamic Energy System model, the Brookhaven National Laboratory models, the Energy Management Simulation and Analysis System, the Hudson-Jorgenson Energy model, Kalter's Parametric Models of Fossil Fuel Markets, the Project Independence Evaluation System, and the Wisconsin Energy model. The review indicates clearly that none of the existing energy models is capable of evaluating all the present energy issues. B.J.

**A76-42487**      **The design and performance of a distributed flow water-cooled solar collector.** D. L. Spencer, T. F. Smith, and H. R. Flindt (Iowa, University, Iowa City, Iowa). In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 252-262.

Design of a flat plate collector which reduces the temperature differential between the absorber plate and the fluid is described. The reduced temperature differences are shown to yield increase collector performance. Flow characteristics of the collector are examined. Collector thermal performance is illustrated for typical operating and environmental conditions. A cost analysis is presented to demonstrate that material and assembly costs are substantially lower than for any collector presently on the market. (Author)

**A76-42488**      **A combined Digital-Analog Tracker for terrestrial applications.** R. C. Durbin, J. L. Boone, and F. J. Kern (Missouri, University, Rolla, Mo.). In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 263-267. 7 refs.

A combined Digital-Analog Tracker is suggested to allow maximum efficiency in a solar-electrical energy converter, utilizing a twelve-foot parabolic collector. The analog tracker compares solar beam radiation to ambient (diffuse) light to obtain optimum placement of the collector when the sun is visible. The digital portion of the tracker utilizes a wired program which derives information on solar position from a non-volatile random-access semiconductor memory. This arrangement allows accurate mapping of the sun even when the sun is obscured by atmospheric phenomena which would make mapping impossible. (Author)

**A76-42489**      **Oil shale R & D - A bureau of mines program.** S. Utter (U.S. Bureau of Mines, Denver, Colo.). In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 286, 287.

The paper describes the work that the Bureau of Mines is doing in oil shale mining to meet the goal of a shale oil production of one million barrels per day by 1985. The immediate objectives of the program are to assess the technical and economic feasibility of various surface and underground mining methods and of modified in situ extraction systems, and to determine the environmental impact of an oil shale mining industry. Attention is paid to the mining of the Piceance Creek Basin of Colorado, which contains a concentration of thick, high-grade shale beds capable of a total production of 470 billion barrels. B.J.

**A76-42490**      **Direct ac generation from solar cell arrays.** F. L. Alvarado (Wisconsin, University, Madison, Wis.) and A. H. Eltimsahy (Toledo, University, Toledo, Ohio). In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 297-306. 9 refs.

Results of the investigation of the performance of solar cells when directly coupled to a conventional three-phase power network are presented. This approach dissociates the electricity production problem from the electric energy storage problem. Extensive studies of the required power inverter are performed. Preliminary simulation results indicate that ac power outputs of better than 90% of the optimum cell power output can be easily achieved by means of a suitably controlled inverter, thereby justifying the elimination of dc loads or local dc electric energy storage devices. It is also shown that the controlling policy for the inverter must depend on the operating conditions of the system, such as cell temperature, solar intensity and power system voltage variations; otherwise the performance of the inverter can deteriorate quite dramatically. (Author)

**A76-42491**      **The impact of direct coupling of solar cell arrays to electric power networks.** A. H. Eltimsahy (Toledo, University, Toledo, Ohio), F. L. Alvarado (Wisconsin, University, Madison, Wis.), and T. W. Boyd. In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 307-315. 6 refs.

The paper has to do with a preliminary investigation of the economic impact of solar cells when directly coupled to a conventional three-phase power network in the Toledo area. A correlation is established between power system demand curves and solar insolation data in the Toledo area using computer simulation. The correlation studies determine how successfully solar cell/inverter systems can alleviate the power system demand during peak hours. Using computer simulation the initial cost of the solar cell/inverter is compared to the economic gains, i.e., money saved from reduced demands on the power network. The time value of money is considered in order to determine how long such a system will have to operate in order to pay for itself. (Author)

**A76-42492**      **Inexpensive inertial energy storage utilizing homopolar motor-generators.** W. F. Weldon, H. H. Woodson, H. G. Rylander, and M. D. Driga (Texas, University, Austin, Tex.). In: *Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975.* North Hollywood, Calif., Western Periodicals Co., 1976, p. 316-321. 17 refs. Research supported by the Electric Power Research Institute, Texas Atomic Energy Research Foundation, and ERDA.

The pulsed power demands of the current generation of controlled thermonuclear fusion experiments have prompted a great interest in reliable, low cost, pulsed power systems. The Energy Storage Group at the University of Texas at Austin was created in response to this need and has worked for the past three years in developing inertial energy storage systems. 0.5 and 5 megajoule homopolar motor-generators have been designed, built and tested at the University of Texas and design studies have been completed for several systems ranging in size up to 63 gigajoules. The performance of the two laboratory machines and the potential applications which have been investigated are discussed. (Author)

**A76-42493** Evaluating the total cost of an on-site solar energy system. D. Costello and J. Bradley (Midwest Research Institute, Kansas City, Mo.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 343-351.

A methodology for evaluating the total or life-cycle cost of an on-site solar energy system is presented. The costs represent after-tax or effective costs realized by the owner of the energy system. The methodology addresses: (1) capital costs; (2) fuel costs; (3) maintenance and operating costs; (4) property taxes; (5) the tax benefits of depreciation; and (6) the investment tax credit. The model was developed for evaluating solar energy systems located at the point where the energy is demanded. However, the methodology also has applicability to many other types of energy systems. (Author)

**A76-42494** An engineering, geological and hydrological environmental assessment of a 250 MMSCFD dry ash Lurgi coal gasification facility. M. H. Somerville, J. L. Elder, and S. R. Moran (North Dakota, University, Grand Forks, N. Dak.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 404-417. 18 refs. Research supported by the Natural Gas Pipeline Company of America.

**A76-42495** How might synthetic fuels from coal affect natural resources and environment. H. J. Plass, Jr. (Miami, University, Coral Gables, Fla.). In: Energy crisis: Two years progress towards self-reliance; Proceedings of the Second Annual UMR-MEC Conference on Energy, University of Missouri, Rolla, Mo., October 7-9, 1975. North Hollywood, Calif., Western Periodicals Co., 1976, p. 423-433. 14 refs.

The paper examines the effects on energy resources and the environment of a possible energy scheme which consists of converting that portion of the electric power industry now based on fossil fuels to the utilization of synthetic gas from coal using combined cycle generation systems. Results are compared with the present mixed fuel system on the basis of a simplified mathematical equilibrium model of the U.S. energy-economic system. The important quantities obtainable from the model are energy flows into the various sectors (Btu/yr), dollar flows into and out of the sectors (dollars/yr), labor (person-hr/yr) devoted to resource extraction and production, and environmental costs (dollars/yr). B.J.

**A76-42587 #** Control of aviation engines used in stationary power plants (Problémy regulácie leteckých motorov použitých v energetike). F. Irman. *Zpravodaj VZLU*, no. 1, 1976, p. 11-15. In Slovak.

Problems encountered in control of aviation gas turbines employed to achieve fast startup of stationary power plants are surveyed. Control requirements and components of the aviation

turboprop engine auxiliary set are described. These sets are used for startup of the power plant from cold, to cover peak loads over short periods, to cover sudden surges in power demands, and as reserve power sources. Handling of outages is discussed, with a worst-case analysis for sudden outage of a main generator dumping the power grid load onto the auxiliary aviation turbine engine, whose rpm increment must then be limited to 10%. Actuation and switching of the turboset, use of pumps, and required improvements in turbine rpm control are discussed. R.D.V.

**A76-42736** Materials for solar photovoltaic energy conversion. K. W. Boer and A. Rothwarf (Delaware, University, Newark, Del.). In: Annual review of materials science. Volume 6.

Palo Alto, Calif., Annual Reviews, Inc., 1976, p. 303-333. 190 refs. NSF Grant No. AER-72-03489.

The paper reviews the types of solar cells and their modes of operation, the theoretical basis of their operation, and the materials used in their construction. Cell types are discussed relative to homojunctions, heterojunctions, Schottky diodes, and liquid-solid contact. Major considerations include first cost (cost per kilowatt), abundance of materials, and power needs. Particular attention is given to cell parameters and their relations to material properties of the cell components. Recent developments regarding Cu<sub>2</sub>O Schottky cells, emulsion cells, organic materials for solar cells, CdS electrolyte, and photogalvanic cells are noted. S.D.

**A76-42739** Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Forum sponsored by the Society of Automotive Engineers. Warrendale, Pa., Society of Automotive Engineers, Inc. (SAE SP-406), 1976. 72 p. Members, \$9.95; nonmembers, \$12.95.

The volume deals with a variety of topics concerning energy resources and their allocation to and use by different forms of transportation. Topics include the economics of energy policy, aircraft energy needs, and energy sources and future availability. C.K.D.

**A76-42740** Aircraft energy needs. G. J. Schott (Boeing Commercial Airplane Co., Renton, Wash.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 5-8.

Aviation accounts for only a small fraction of the total annual consumption of petroleum based fuels for transportation. Air transport fuels must be globally available, fluid at operational temperatures and pressures, and priced to allow profitable operations, and must have a high heating value, high density, and, preferably, a low vapor pressure. Of the potential replacements for petroleum based fuels (liquid hydrogen, liquid methane, methanol, and synthetic kerosene), synthetic kerosene is judged most likely to satisfy these requirements. A number of technological improvements, such as automatic flight management, advanced aerodynamics, laminar flow control, advanced engines, and advanced structural materials, could lead to significant reductions in fuel requirements; the development of new technologies is, however, dependent on the economic health of the aviation industry. C.K.D.

**A76-42741** Energy utilization by various modes of transportation. R. E. Goodson (Purdue University, Lafayette, Ind.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 9-16. 48 refs.

The energy efficiency of different modes of transportation is examined, and the potential for energy savings in transportation is

considered. Emphasis is placed on highway and rail modes. Recommended measures and goals include a fleet average of at least 21 mpg by 1990 and 25 mpg by 2000 for automobiles, efficiency improvements of 20-30% for trucks, institution of flexible van pools for commuting trips, increased load factors for freight transport, use of rail, water, or pipelines for line haul freight with dispersal by truck from pick-up points, scheduling air traffic to foster higher load factors, and increased capital investment for mass transit in selected areas. It is estimated that total implementation of these goals and measures could result in a 30% reduction in energy use from present levels for a population 25-35% greater by the year 2010. C.K.D.

**A76-42742 Fuels for transportation.** W. J. Coppoc (Texaco, Inc., New York, N.Y.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 23-28, 8 refs.

The types of fuel used for different modes of transportation are discussed, and exploration, production, refining, and distribution techniques for petroleum, oil shale, and tar sands are outlined. Difficulties involved in the handling of solid crude materials are considered. The need to reduce the fuel specificity and increase the efficiency of engines to stretch fuel resources is emphasized. C.K.D.

**A76-42743 Non-transportation uses for petroleum - Impact on fuel availability.** E. F. Loveland (Shell Oil Co., Houston, Tex.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 29-36.

In the context of increasing competition for available petroleum from the private, commercial, and industrial sectors of the economy, the materials other than fuels for transportation which are produced from crude oil are discussed. Preferential allocation of gas and oil supplies to the residential market is expected to continue until electricity is substituted, leaving a shortage in the amounts of these materials available to industry for fuels and feedstocks. It is suggested that finite resources of gas and oil be conserved when possible by converting them into products which are longer lasting or more easily replaced by alternate materials or energy sources than fuels. C.K.D.

**A76-42744 Alternative automotive engines and energy conservation.** J. B. Heywood and L. H. Linden (MIT, Cambridge, Mass.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 37-53, 11 refs.

The potential ability of alternatives to the internal combustion engine (ICE) to contribute towards the dual goals of reduction in the power consumed by the United States passenger car fleet and reduction in air pollutant emissions is assessed. The principal advantages and limitations of a variety of alternative engines are identified, including the Wankel spark-ignition engine, the carbureted prechamber stratified charge spark ignition engine, the diesel engine, the fuel-injected stratified charge spark ignition engine, the gas turbine engine, Rankine and Stirling cycle engines, heat engine hybrid systems, and the battery-powered electric system. A procedure for evaluating the relative merits of these candidate systems which takes into account the total life-cycle costs (in terms of capital, man-hours, and materials in addition to fuel consumption and emissions) and includes an appropriate capital charge for the progressive decrease in the value of the vehicle itself is developed. The process of automotive technology development and production is discussed. C.K.D.

**A76-42745 Alternate transportation fuels.** G. A. Mills (ERDA, Washington, D.C.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975.

Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 55-63, 12 refs.

Alternative transportation fuels derived from coal are discussed, with emphasis on U.S. Energy Research and Development Administration coal liquefaction programs. The status of major ERDA coal liquefaction installations, representing the four generic methods of converting coal to liquid fuel - pyrolysis, direct catalytic hydrogenation, solvent extraction, and indirect liquefaction - is outlined. The characteristics of fuels derived from these processes are described, together with the refining procedures required to produce gasoline and other transportation fuels from the liquid crudes. The importance of developing engines which can operate on wide-boiling range distillate fuel is stressed. C.K.D.

**A76-42746 Investment picture for U.S. energy needs.** J. A. Horner (Texas Commerce Bank, Tex.). In: Energy and transportation; Proceedings of the Forum, Detroit, Mich., October 15, 1975. Warrendale, Pa., Society of Automotive Engineers, Inc., 1976, p. 65-69.

The question as to whether enough investment can be made in petroleum exploration and in development of new oil fields to meet growing energy demands while reducing the existing levels of dependence on imports is examined. It is estimated that only 41-68% of the required capital investment can be met by the industry without resorting to sharp increases in the use of long-term debt, assuming a continuation of the present two-tier oil pricing system. It is concluded that a workable financing of the nation's energy needs within the context of the world economic community can be accomplished, provided that total self-sufficiency is not targeted within the next ten years, that oil prices are decontrolled, and that any windfall profits tax that might be imposed is balanced by adequate ploughback provisions. C.K.D.

**A76-42851 The energy accounting of materials, products, processes and services; Proceedings of the Ninth International Conference, Rotterdam, Netherlands, February 26, 27, 1976.** Conference sponsored by the Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, Vereniging van der Nederlandse Chemische Industrie, and Federatie Metaal - en Electrotechnische Industrie. Edited by A. Verbraeck. The Hague, Roeland Foto-Offset, 1976, 171 p.

Questions related to the definition and the measurement of units in energy accounting are considered along with an economics and energy analysis, energy accounting in food products, and an energy analysis of transportation systems. Attention is also given to an energy accounting of packaging materials for liquids and their transport, an energy accounting of steel, an energy accounting of aluminum, the energy requirement of some energy sources, and an energy analysis of materials and structures in the building industry. G.R.

**A76-42852 # Economics and energy analysis.** T. V. Long, II (Chicago, University, Chicago, Ill.). In: The energy accounting of materials, products, processes and services; Proceedings of the Ninth International Conference, Rotterdam, Netherlands, February 26, 27, 1976. The Hague, Roeland Foto-Offset, 1976, p. 15-38, 13 refs.

A descriptive energy analysis is considered and questions related to physical efficiency and economic efficiency are examined. Applications of energy analysis are also discussed, taking into account international comparisons of energy conserving technologies, an assessment of the impacts of technological change, and approaches for a maximization of return on investment. Possibilities

concerning a substitution of elements in production are investigated and attention is given to a determination of physical bounds on economic activity. G.R.

**A76-42853 # Energy analysis of transportation systems.** E. J. Tuininga (Centrale Organisatie voor Toegepast - Natuurwetenschappelijk Onderzoek, Apeldoorn, Netherlands). In: The energy accounting of materials, products, processes and services; Proceedings of the Ninth International Conference, Rotterdam, Netherlands, February 26, 27, 1976. The Hague, Roeland Foto-Offset, 1976, p. 67-82. 12 refs.

The energy requirements for a vehicle include several components which are related to vehicle construction, vehicle fuel consumption, vehicle maintenance, and the infrastructure used by the vehicle. The energy requirements for present transportation systems are examined, taking into account passenger cars, trucks, and various types of trains. New developments in the design and the production of cars are considered, giving attention to production technology, new materials, safety, emissions, and aerodynamic factors. An energy analysis of new transportation technologies is also conducted. G.R.

**A76-42854 # Energy requirement of some energy sources.** P. F. Chapman and D. F. Hemming (Open University, Bletchley, Bucks., England). In: The energy accounting of materials, products, processes and services; Proceedings of the Ninth International Conference, Rotterdam, Netherlands, February 26, 27, 1976. The Hague, Roeland Foto-Offset, 1976, p. 119-140. 15 refs. Research supported by the Department of the Environment.

A process analysis of Middle East oil is conducted, taking into account data concerning drilling operations, aspects of exploration, production data, and transportation requirements. A similar analysis is carried out for North Sea oil. Possibilities regarding the utilization of oil shales are also investigated, giving attention to limitations related to water requirements, mining procedures, crushing operations, retorting processes, and upgrading facilities for the raw shale oil. The results of an energy analysis of nuclear power are also considered. G.R.

**A76-42957 Energy recovery from refuse - State-of-the-art.** J. Payne (Department of the Environment, Ottawa, Canada). *American Society of Civil Engineers, Environmental Engineering Division, Journal*, vol. 102, Apr. 1976, p. 281-300. 31 refs.

The practice of energy recovery from municipal solid waste is becoming increasingly widespread in North America as the prices of fossil fuels rise. The present state in the technology of energy recovery is discussed relative to the following methods which are at various stages of development: burning raw refuse in steam-generating incinerators, burning prepared refuse in modified existing or new steam generators, pyrolysis, hydrogenation, controlled anaerobic digestion, and recovery of methane from landfills. Installations in North America have pioneered the technology of solid fuel preparation which basically consists of refuse shredding and separation of the light combustible fraction by air classification. By 1980, pyrolysis plants will play a major role in solid waste management. Recovery of methane from landfill is already commercialized. S.D.

**A76-42960 Air pollution impact of railroad electrification.** H. B. H. Cooper, Jr. (Texas University, Austin, Tex.), H. A. Richards (Texas A & M University, College Station, Tex.), and A. T. B. Lam (Washington University, Seattle, Wash.). *American Society of Civil Engineers, Environmental Engineering Division, Journal*, vol. 102, Aug. 1976, p. 723-736. 21 refs.

Railroad electrification provides a positive means for meeting transportation needs without increased reliance upon foreign petroleum fuels, where the necessary electricity can be generated in

central power plants using domestically available coal or nuclear power. Substantial reductions in air pollutant emission rates as compared to other freight and passenger transportation modes can be obtained by railroad electrification in an intercity corridor. The result of railroad electrification is a decreased potential for exposure of affected populations to air pollutants in adjacent urban areas. Overall energy savings of 5 to 10% may be realized by conversion from diesel to electric railroad operation. There is need for more carefully defined energy consumption requirements for electric locomotive operations as compared to other modes. S.D.

**A76-42964 Environmental implications of oil-shale development.** P. D. Kilburn (Woodward-Clyde Consultants, Denver, Colo.). *Environmental Conservation*, vol. 3, Summer 1976, p. 101-115. 40 refs.

The paper discusses the environmental impacts of oil shale technology, with particular reference to the development of the Piceance Creek Basin, Colo. Attention is given such environment-related issues as hydrology, water quality and salinity, the surface disposal of processed shale, revegetation, ecology, air quality, and socio-economic impacts. The movement to provide a system of natural areas throughout the Basin is considered. Such a system would maintain important examples of vegetation types, wildlife habitat, geological and archeological features, and would maintain natural areas both as ecological baselines and as nuclei for obtaining biological 'seed' for rehabilitation of disturbed areas. B.J.

**A76-42965 The economic use of subsidies for urban mass transportation.** R. A. Mundy (Tennessee University, Knoxville, Tenn.). *Transportation*, vol. 5, June 1976, p. 123-133. 9 refs.

**A76-42978 # Remarks concerning the effect of hydroelectric projects on complex management of water resources (Consideratii privind efectul amenajarilor hidroenergetice in gospodaria complexa a apelor).** P. Stegaroiu and A. Godeanu (Institutul de Cercetari si Proiectari pentru Gospodaria Apelor, Rumania). *Hidrotehnica*, vol. 21, July-Aug. 1976, p. 77-80. In Rumanian.

The paper examines data on the exploitation modes planned for some large-volume mountain reservoirs serving hydroelectric purposes from the viewpoint of hydrographic management. Monthly and seasonal trends of reservoir volumes and flows are studied, and the possibility of uniformization of the general regional water flow over the year, at the same time considering energy requirements, is investigated. P.T.H.

**A76-42986 The significance of lignite from the Rhine area for the power economy of the state North Rhine-Westphalia (Die Bedeutung rheinischer Braunkohle für die Energiewirtschaft des Landes Nordrhein-Westfalen).** P. Speich (Rheinische Braunkohlewerke AG, Cologne, West Germany). *Energiewirtschaftliche Tagesfragen*, Jan.-Feb. 1976, p. 18-23. In German.

During 1974 43% of the electric power for the state North Rhine-Westphalia of the Federal Republic of Germany was obtained by a utilization of lignite from deposits in the Rhine area. The lignite provided about the same percentage of the fuel for residential heating. It is expected that the importance of the lignite resources for the power economy of the German state will further increase in connection with recent worldwide developments in the energy sector. Attention is given to the mining of lignite, the structure of the market for lignite, the use of lignite in metallurgical processes, and lignite gasification processes. G.R.

**A76-42987 Electric-vehicle tests in North Rhine-Westphalia (Elektrofahrrzeug-Erprobung in Nordrhein-Westfalen).** A. Cupsa and H.-G. Müller (Gesellschaft für elektrischen Strassenverkehr mbH, Düsseldorf, West Germany). *Energiewirtschaftliche Tagesfragen*, Jan.-Feb. 1976, p. 36-38. In German.

The use of vehicles which obtain their propulsion energy from electric storage batteries is considered, taking into account certain problems which are related to the characteristics of battery-recharging operations. A description is given of a test program related to the employment of electric buses. The program involved the use of 20 electric buses on three bus lines. The electric battery was carried on a separate trailer. Batteries were exchanged after about 80 km. Another project is concerned with the use of electric vehicles for carrying freight. G.R.

**A76-42988** The concept of profit planning in electric-power generation (Die Konzeption einer Gewinnplanung bei der Erzeugung von elektrischer Energie). H. Brachmann. *Energiewirtschaftliche Tagesfragen*, Mar. 1976, p. 105-107. In German.

The notion of an 'appropriate' rather than a maximum profit is considered as a basis for the planning process, taking into account the function of the electric power industry to provide power for the public. The mathematical relations which are required for planning and controlling profit are considered. Connections between efficiency, price relations, and performance are demonstrated with the aid of a graph. G.R.

**A76-42989** Ideas concerning the usefulness and the necessity for a comprehensive surveillance with respect to misuse in the area of public energy-supply systems (Gedanken über die Nützlichkeit und Notwendigkeit einer zusammenfassenden Missbrauchsaufsicht im Bereich der öffentlichen Energieversorgung). K. Sachs (SCHLESWAG AG, Rendsburg, West Germany). *Energiewirtschaftliche Tagesfragen*, Apr. 1976, p. 161-164. In German.

The meaning of the concept 'energy' is examined, taking into account the necessity for a dependable energy-supply system as a basis for the economy and human life of today. Objectives of a legal consideration of aspects and factors which are related to the supply of energy are discussed. One important legal objective is concerned with surveillance functions regarding possible abuses and undesirable developments. Attention is given to basic laws related to the power economy, the law against the restriction of competition, legal regulations concerning price and cost developments, and provisions with respect to environmental protection. G.R.

**A76-42990** High-temperature solar collectors (Hochtemperatursolarkollektoren). H. Kleinwächter and J. Kleinwächter. (Schweizerische Vereinigung für Sonnenenergie, Symposium, 3rd, Zurich, Switzerland, Dec. 1, 1975.) *Energiewirtschaftliche Tagesfragen*, June 1976, p. 286-290. In German.

A description is presented of investigations which were conducted to develop new economic devices for the concentration of solar radiation. A magnetohydrodynamic generator with a concave reflector for the concentration of solar radiation is considered. Attention is also given to a cylindrical parabolic mirror with a variable geometry, a pneumatic concave reflector, and various mirror types with funnel design characteristics. G.R.

**A76-42991** Energy models critically examined (Energie-modelle kritisch gesehen). F. Hansmann. *Energiewirtschaftliche Tagesfragen*, June 1976, p. 291-294, 8 refs. In German.

The characteristics of long-term planning are examined. Long-term planning as considered in the reported investigation is the determination of the next steps, taking into account the long-term future. It is pointed out that the current energy models rely almost without an exception on long-term forecasts concerning the energy requirements. Attention is given to approaches for improving long-term energy models. G.R.

**A76-42992** Global energy planning (Globale Energieplanungen). H. G. Mebus. *Energiewirtschaftliche Tagesfragen*, June 1976, p. 295, 296. In German.

The economic relations between industrialized countries and developing nations are examined, taking into account the possibility for the developing nations to provide in exchange for industrial products, in addition to raw materials, also energy for the industrialized countries. After the exhaustion of the petroleum reserves, the oil exporting countries can obtain energy on the basis of a utilization of solar energy. Suitable approaches and requirements for the preparation of such an energy export are discussed. G.R.

**A76-42993** Topical problems of energy policy (Aktuelle Probleme der Energiepolitik). U. Engelmann. *Energiewirtschaftliche Tagesfragen*, July 1976, p. 344, 346, 348, 350, 352. In German.

West German energy programs which came out of the recent international oil crisis are briefly discussed, as are the prospects for oil and coal-based energy technology in West Germany in the near future. The mining of hard coal in Germany is considered as one way of ensuring an energy supply to meet Germany's electricity needs. Alternate energy sources are discussed with emphasis on nuclear energy, examining licensing and qualification procedures and the standardization of nuclear power plants. Legislative issues pertaining to energy conservation are examined, together with the legal aspects of energy policy. International cooperation in the field of energy is considered, with a discussion of the accomplishments of the International Energy Agency of Paris. The pooling of international reserves in case of another energy crisis is considered, together with such issues as conservation and the development of alternate sources. B.J.

**A76-43008** Power from urban refuse. J. E. Marshall (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England). *Electrical Engineer*, vol. 53, May 1976, p. 25, 26. 6 refs.

The article discusses the refuse scheme of the Imperial Metal Industries, called Waste Utilization Project Energy. The method used treats domestic refuse as any other fuel, i.e., prepares it for burning. In order to present the greatest surface area of fuel for combustion, the refuse will be reduced in size so that none will be greater than 150 mm and at least 80% of it will be less than 50 mm. The refuse will be shredded prior to combustion and any noncombustible material of value will be recovered. Due to the potential difficulties in igniting refuse, it will be necessary to fire it in conjunction with a conventional fuel. The refuse ultimately will be used to fuel the power plant of the Imperial Metal Industries. B.J.

**A76-43009** Heat-flow near a North Atlantic fracture zone. S. E. Foster (NOAA, Environmental Data Service, Washington, D.C.), G. Simmons (MIT, Cambridge, Mass.), and W. Lamb (Rhode Island, University, Kingston, R.I.). *Geothermics*, vol. 3, Mar. 1974, p. 3-16. 67 refs. NSF Grants No. GA-1077; No. GA-16078; Contract No. Nonr-241.

Fifteen new heat-flow measurements are reported, fourteen of which are located in or near a fracture zone near 43 degrees N on the mid-Atlantic Ridge. These data, combined with earlier nearby measurements, show the fracture zone to have an observable positive effect on the regional heat-flow field. A good correlation is observed between large near-bottom water potential temperature gradients and the occurrence of significant variations with depth in the measured rate of heat-flow. One measurement was taken in the Horseshoe abyssal plain west of Gibraltar and gave a value of 1.38 microcal/sq cm s. (Author)

**A76-43010** Evidence for two possible relationships between observable surface deformation and geothermal activity. J. L. Brander (Imperial College of Science and Technology, London,

England). *Geothermics*, vol. 3, Mar. 1974, p. 17-20. 11 refs. Research supported by the Natural Environment Research Council.

During September 1967, an earthquake swarm which lasted eight days accompanied a large increase in activity of a previously small geothermal field in southwest Iceland. A combination of field measurements and precise distance measurements, made on a network of permanent benchmarks established soon after the earthquake swarms, shows the accompanying surface faulting to be secondary shearing of the type associated with large strike-slip faults. It is suggested that measurements of surface faulting in the immediate vicinity of a producing geothermal field could provide information on the gross permeability of the deep aquifers, thus suggesting how the field would behave under high discharge rates, such as would be encountered during cost-effective geothermal exploitation. B.J.

**A76-43011**      **Temperature transients in flowing boreholes.** G. Bodvarsson, R. S.-M. Lu (Oregon State University, Corvallis, Ore.), and R. P. Lowell (Georgia Institute of Technology, Atlanta, Ga.). *Geothermics*, vol. 3, Mar. 1974, p. 21-24.

The problem of temperature transients in a borehole which has been drilled into an isothermal homogeneous solid and which is flowing at a constant rate is considered. At a fixed time, the temperature of the fluid entering the borehole at the bottom is raised by a given amount. The theoretical expression for the temperature response of the borehole is derived, and a few numerical data of practical value are given. (Author)

**A76-43012**      **Systematic approach to geothermal development.** H. C. H. Armstead, H. L. Gorhan, and H. Müller (Motor-Columbus Consulting Engineers, Inc., Baden, Switzerland). *Geothermics*, vol. 3, June 1974, p. 41-52. 11 refs.

The paper suggests a systematic methodology for undertaking geothermal exploration in a logical sequence of operations with the greatest possible economy of expense and effort. A process diagram is presented, together with a commentary on each operation and each question demanding an answer. These operations and questions include an inventory of alternative energy costs, the competitiveness of geothermal energy, the collection of more extensive field data, deep exploratory drilling and borehole measurements, an estimation of energy potential of a field, whether a pilot plant is required, and whether there is a demand for waste heat from the power plant. B.J.

**A76-43013**      **The application of the Na-K-Ca geothermometer to thermal areas of Utah and the Imperial Valley, California.** C. A. Swanberg (U.S. Bureau of Reclamation, Boulder City, Nev.). *Geothermics*, vol. 3, June 1974, p. 53-59. 15 refs.

The Na-K-Ca geothermometer uses the results of Fournier and Truesdell (1973) who found that Na-K-Ca data can be used to determine the last temperature at which water-rock equilibrium was attained. This geochemical method of geothermal exploration is applied to a regional analysis of the 48 major thermal springs of Utah. Roosevelt Hot Springs shows the greatest geothermal potential, where estimated temperatures are nearly 300 C. Detailed studies of LaVerkin Hot Spring, Wilson Hot Springs, and Abraham Hot Springs, Utah, and the Mesa anomaly, Imperial Valley, Calif., are also presented. B.J.

**A76-43015**      **Terrestrial heat flow measurements near Rosignano Solvay /Tuscany/, Italy.** M. Fanelli, P. Squarci (CNR, Istituto Internazionale per le Ricerche Geotermiche, Pisa, Italy), M. Lodo, and F. Mongelli (Bari, Università, Bari, Italy). *Geothermics*, vol. 3, June 1974, p. 65-73. 19 refs.

Heat flow measurements were made in three wells close together

on the Tyrrhenian coast of Tuscany. The average value of the temperature gradient was 62.8 C/km, that of thermal conductivity of the rocks was 3.79 mcal/(cm s C). The heat flow obtained was 2.55 microcal/(sq cm s) (107 mW/sq m). These are values corrected for local effects (palaeoclimatic variations, the influence of the sea). In particular, a correction was made for the climatic variations of the last 10,000 years based on climatological evidence. (Author)

**A76-43016**      **Geothermal resource energetics.** G. Bodvarsson (Oregon State University, Corvallis, Ore.). *Geothermics*, vol. 3, Sept. 1974, p. 83-92. 10 refs. NSF Grant No. GA-41784.

The theory of geothermal heat extraction is discussed on the basis of the three simple idealized models, that is, (1) single fracture flow, (2) intergranular flow, and (3) intergranular vaporization models. Theoretical expressions for the total available specific resource energy per unit area or unit volume are given. These results are illustrated by a number of numerical data which are useful in the assessment of the potential of individual geothermal resources. (Author)

**A76-43017**      **Regenerative vapor cycle with isobutane as working fluid.** J. C. S. Chou, R. K. Ahluwalia, and E. Y. K. Woo (Hawaii, University, Honolulu, Hawaii). *Geothermics*, vol. 3, Sept. 1974, p. 93-99.

One of the methods of generating geothermal power is to use a suitable working fluid which extracts heat from geothermal fluids and generates power in a closed cycle. This paper presents a discussion of an improvement of the basic closed cycle with isobutane as a working fluid. A regenerative heat exchanger is added for heating the cold condensate of isobutane with the highly superheated exhaust. The addition of this heat exchanger can result in a significant reduction in the size of heat rejection equipment. Furthermore, the waste brine of the improved system is at such a high temperature that the waste heat can be economically utilized for desalting water for industrial uses. (Author)

**A76-43019**      **Preliminary studies of some geothermal areas in India.** M. L. Gupta and B. S. Sukhija (National Geophysical Research Institute, Hyderabad, India). *Geothermics*, vol. 3, Sept. 1974, p. 105-112. 22 refs.

**A76-43022**      **Solid waste fuel pellets provide fuel supplement.** H. K. Elo and F. R. Rhodes (Elo and Rhodes Consulting Engineers, Easton, Pa.). *Pollution Engineering*, vol. 8, Feb. 1976, p. 32, 33.

The use of pelletized municipal solid wastes for a supplemental industrial fuel has been demonstrated. Ferrous materials are removed from these wastes by means of magnetic drums; glass and rubble are removed in the process of successive air and mechanical separation. The combustible material is shredded and compacted into pellets with a bulk density of 30 pcf. The effective fuel value of the pellets at the normal moisture content of 20% is 6600 Btu/lb. The pellets can be dried to attain a heat value of 8500 Btu/lb. C.K.D.

**A76-43026**      **The role of hydrogen in the energy future of the United States.** D. P. Gregory (Institute of Gas Technology, Chicago, Ill.). *International Journal of Hydrogen Energy*, vol. 1, June 30, 1976, p. 109-112.

The characteristics of hydrogen energy (production, transmission, storage, ammonia and methanol production, fossil fuel upgrading, fuel for internal combustion engines) are discussed. It is suggested that the U.S. national energy policy should be directed

toward the ultimate goal of a mixed hydrogen-electricity energy system because both of these energy forms can be made from a wide variety of abundant, domestic primary energy sources. Current hydrogen energy research should be focused on the production area, with slightly less emphasis put on energy storage, and the conversion of natural gas transmission and distribution equipment to the use of hydrogen. The problems to which government agencies should direct hydrogen energy research are addressed. B.J.

**A76-43027 \*** NASA Space Program experience in hydrogen transportation and handling. A. L. Bain (NASA, Kennedy Space Center, Cocoa Beach, Fla.). *International Journal of Hydrogen Energy*, vol. 1, June 30, 1976, p. 173-188.

This paper portrays the experience gained in the transportation and handling of hydrogen in support of the Apollo launch site at Kennedy Space Center (KSC), Fla., one of NASA's prime hydrogen users in the Space Program. The objective of the paper is basically to reveal the types of systems involved in handling hydrogen, safety practices, operational techniques, other general experience information, and primarily to convey the routinism by which this potential fuel of the future has already been handled in significant quantities for a number of years. (Author)

**A76-43028** Fossil/hydrogen energy mix and population control. T. N. Veziroglu, S. Kakac, O. Basar, and N. Forouzanmehr (Miami, University, Coral Gables, Fla.). (*National Science Foundation and Japan Society for Promotion of Science, U.S.-Japan Joint Seminar on Key Technologies for the Hydrogen Energy System, Tokyo, Japan, July 20-23, 1975.*) *International Journal of Hydrogen Energy*, vol. 1, June 30, 1976, p. 205-217. 14 refs.

An energy system based on fossil and synthetic hydrogen fuel, mixed at various ratios, has been considered as a function of some population growth controls. The results indicate that the increased use of hydrogen and slowing down the population growth would have beneficial effects on various world parameters such as pollution, resource conservation and the quality of life. (Author)

**A76-43029** Hydrogen energy bibliography. K. E. Cox and M. Natarajan (New Mexico, University, Albuquerque, N. Mex.). *International Journal of Hydrogen Energy*, vol. 1, June 30, 1976, p. 221-225. 110 refs.

**A76-43030 #** Wind energy utilisation - New Zealand's prospects. R. E. Chilcott (Lincoln College, Canterbury, New Zealand). *New Zealand Energy Journal*, vol. 49, Mar. 25, 1976, p. 40-42. 10 refs.

The feasibility of wind energy converters in New Zealand is assessed. The hourly mean wind power intensity for New Zealand is estimated to be about 150 W/sq m at a height of 10 m. The approach used to evaluate converter performance is described for three starting problems: given system and rated wind speed, average wind speed variable; given system and average wind speed, rated wind speed variable; given average wind speed and load factor, type of system variable. Assuming an allowable installed capacity of 5 kW/ha and a load factor of 0.4, the annual potential wind energy output for New Zealand is estimated to be 17.5 MWh/ha, compared with an average incident solar energy of 14 GWh/ha. C.K.D.

**A76-43041 #** Selecting the parameters of an optimal MHD generator with a high energy conversion factor (O vybore parametrov optimal'nogo MGD-generatora s bol'shim koefitsientom preobrazovaniia energii). V. V. Breev, A. V. Gubarev, and V. V. Lebedev. *Magnitnaia Gidrodinamika*, Apr.-June 1976, p. 83-90. 21 refs. In Russian.

It is proposed to apply the methods of the mathematical theory

of optimal processes to the selection of optimal MHD-generator parameters. The search algorithm devised is based on the realization of the 'traveling wave' method for a system of ordinary differential equations describing the channel-flow of an electrically conducting gas, with allowance for turbulent boundary layer development. The algorithm is applied to the solution of a parameter selection problem in a sufficiently general formulation, with allowance for constraints placed on the control and the phase variables. V.P.

**A76-43042 #** Influence of the turbulent boundary layer on the characteristics of a Faraday MHD generator with solid electrodes (O vlianii turbulentnogo pogranichnogo sloia na kharakteristiki Faradeevskogo MGD-generatora so sploshnymi elektrodami). V. V. Breev, A. V. Gubarev, and V. P. Panchenko. *Magnitnaia Gidrodinamika*, Apr.-June 1976, p. 91-99. 15 refs. In Russian.

The paper analyzes the flow conditions in linear MHD channels with solid electrodes and various flare angles. Turbulent boundary layer development and separation is considered, showing that boundary layer separation impairs such MHD characteristics as energy conversion. The problem is discussed of designing a channel profile that would prevent flow separation and would provide effective energy conversion. A variational problem of designing an optimal MHD generator free of separation effects is formulated, and approaches to its solution are discussed. V.P.

**A76-43051 #** Automatization - A possibility for increasing the effectiveness of electric power generation (Die Automatisierung - Eine Möglichkeit zur Steigerung der Effektivität in der Elektroenergieerzeugung). W. Teichmann (Zittau, Ingenieurhochschule, Zittau, East Germany). (*Kammer der Technik, Fachkolloquium über Automatisierung von Kraftwerken, Ingenieurhochschule Zittau, Zittau, East Germany, Oct. 30, 31, 1975.*) *Energietechnik*, vol. 26, July 1976, p. 286-290. 5 refs. In German.

General aspects concerning the use of automatization techniques in power stations are considered and control procedures for the improvement of the process characteristics are examined. An investigation is conducted regarding the effect of modern regulation procedures on power station operation. Effects of automatization on the economy of power-station operation are also studied. G.R.

**A76-43053 #** A contribution to the evaluation of the effectiveness of territorial energetic supply variants (Beitrag zur Bewertung der Effektivität territorialer energetischer Versorgungsvarianten). V. Haupt (Dresden, Technische Universität, Dresden, East Germany). (*Energiewirtschaftliche Tagung, Technische Universität Dresden, Dresden, East Germany, May 22, 23, 1975.*) *Energietechnik*, vol. 26, July 1976, p. 304-311. 8 refs. In German.

The basic objectives involved in providing industry and population with energy are examined and approaches for increasing the effectiveness of the production processes are considered. The significance of investment factors is investigated. Attention is given to the relativity of expenditure minimum or effectivity maximum and the formulation of a model concerning the total expenditure required under conditions of intensive extended production. G.R.

**A76-43054 #** Objectives concerning the design of a uniform complex analysis of basic-funds reproduction in the coal and energy sector (Aufgaben beim Aufbau einer einheitlichen komplexen Analyse der Grundfondsreproduktion im Bereich Kohle und Energie). A. Frenzel, I. Kalzikis, and R. Zitzmann (Institut für Energetik, Leipzig, East Germany). (*Ministerium für Kohle und Energie, Kolloquium, Leipzig, East Germany, Mar. 18, 1975.*) *Energietechnik*, vol. 26, July 1976, p. 325-327. 5 refs. In German.

The basic-funds analysis is to provide an instrument for the direction of activities related to coal and energy considerations in the German Democratic Republic. The criteria which determine the basic-funds analysis are discussed. Attention is given to approaches for obtaining the required data and developing suitable data processing procedures. G.R.



**A76-43146 \* #** The requirements for batteries for electric vehicles. H. J. Schwartz (NASA, Lewis Research Center, Cleveland, Ohio). U.S. Army, COMSAT, NASA, and ERDA, *Power Sources Symposium, 27th, Atlantic City, N.J., June 21-24, 1976, Paper. 6 p.* 10 refs.

The paper reassesses the role of electric vehicles in the modern transportation system and their potential impact on oil consumption. Three major factors determining the size of this impact are discussed: the market potential, the date of introduction, and the rate of consumer acceptance. The strategy of selecting the battery type for an urban car to introduce in coming years is analyzed. The results of the analysis suggest that the research and development emphasis should be placed on near- and mid-term battery technology. From the standpoint of maximizing both the cumulative impact and the benefits derived in the year 2000, however, a strategy of early introduction of near-term and mid-term cars followed by the far-term vehicles seems to produce the optimum result. S.N.

**A76-43151 \*** Hydrogen - Primary or supplementary fuel for automotive engines. J. G. Finegold (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Society of Automotive Engineers, West Coast Meeting, San Francisco, Calif., Aug. 9-12, 1976, Paper 760609.* 15 p. Contract No. NAS7-100.

Hydrogen, gasoline, and mixtures thereof were compared as fuels for lean-burn engines. Hydrogen for the mixed fuels tests was generated by partial oxidation of gasoline. Hydrogen combustion yielded the highest thermal efficiency at any NOx level. Gasoline yielded the second highest thermal efficiency for NOx levels greater than or approximately equal to 2 gm/mi. For lower NOx levels and high vehicle inertia weights, progressively more hydrogen supplementation was the second most efficient system. For vehicle inertia weights below 5000 lbm (2300 kg), the statutory NOx standard (0.4 gm/mi) could be met with 1 lb/hr (0.13 g/s) hydrogen supplementation. (Author)

**A76-43176** CCMS Solar Energy Pilot Study. F. H. Morse and I. B. Rose (Maryland, University, College Park, Md.). (*International Solar Energy Society, International Solar Energy Congress and Exposition, University of California, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 4, 1976, p. 273-280. 16 refs.

The objective of the Solar Energy Pilot Study of the Committee on the Challenges of Modern Society (CCMS) of the North Atlantic Treaty Organization (NATO) is the exchange of information on solar heating and cooling-systems programs and projects of each participating country so as to encourage the cost-effective and practical application of solar energy to heating and cooling in residential, commercial, industrial, agricultural, and public buildings. The key elements in this information exchange are: (1) preparation and distribution of special reports, prepared in an agreed format, on certain projects in the participating country; (2) distribution of relevant and publically available reports concerned with solar heating and cooling systems in buildings; and (3) participation in meetings for the review of research, development, and demonstration programs as well as discussions and exchange of information and ideas. In this paper, the CCMS Solar Energy Pilot Study is described, and recent activities are reviewed. (Author)

**A76-43177** A terrestrial solar energy power system. T. Tani, S. Sawata, and T. Horigome (Electrotechnical Laboratory, Tokyo, Japan). *Solar Energy*, vol. 18, no. 4, 1976, p. 281-285. 5 refs.

A terrestrial solar-energy power system is outlined which consists of a solar collector system, heat transfer system, heat storage and exchange system, and power generation system. A selective thin barrier made from soda-lime glass and a chemically treated metallic surface are proposed as radiation materials for the solar collector. An experimental model of the present power system is described, and it is shown that an energy-collecting area of 14.44 sq km is required to generate 1000 MW of electrical energy. Some problems requiring further attention are noted, particularly the development of high-temperature high-reliability materials and components. F.G.M.

**A76-43178** The behaviour of adsorbent energy storage beds. D. J. Close and T. L. Pryor (North Queensland, University, Townsville, Australia). *Solar Energy*, vol. 18, no. 4, 1976, p. 287-292. 19 refs. Research supported by the Commonwealth Scientific and Industrial Research Organization.

The paper describes a numerical study of the behavior of packed beds containing adsorbent material and used for thermal-energy storage. The basic model assumes that the packed bed is composed of straight parallel channels in an otherwise solid material, that the transport of heat and water vapor from the air to the adjacent solid is governed by forced convection coefficients, and that the thermal and adsorption properties of the materials are constant. It is found that the heat-exchange performance of two adsorbent beds (one containing silica gel and another containing activated alumina) is inferior to that of a gravel bed, but their performance on a relative-humidity basis is superior. It is concluded that adsorbent beds can be much smaller than nonadsorbent ones, are relatively insensitive to thermal losses, and are more suited to energy storage for drying purposes rather than for simple heating purposes. F.G.M.

**A76-43179** The Dead Sea - A scheme for a solar lake. G. Assaf (Weizmann Institute of Science, Rehovot, Israel). *Solar Energy*, vol. 18, no. 4, 1976, p. 293-299. 20 refs.

A scheme aimed at modifying the Dead Sea into a solar lake is outlined. The scheme assumes that the solar lake will occupy the northern basin of the sea, and its basic idea is to reduce mixing over the lake by floating wind breaks which might consist of a partially submerged net stabilized by anchored cables. The balance of salt and mass in the lake is analyzed along with the physics of vertical mixing, the heat balance with respect to solar radiation, and conditions at the hypolimnion. The most important unknown in the analysis is shown to be related to the nature of mixing or the influence of wind action on a stratified fluid. For a temperature of 80 C, the optimum depth of the halocline is estimated to be 1.3 to 1.5 m, and the theoretical energy-recovery rate is estimated to be 50 to 70 W of heat and 9 to 12 W/sq m for a Carnot engine, depending on the extinction coefficient. F.G.M.

**A76-43180** Long-term /18 years/ performance of a residential solar heating system. J. C. Ward and G. O. G. Lof (Colorado State University, Fort Collins, Colo.). (*International Solar Energy Society, International Solar Energy Congress and Exposition, University of California, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 4, 1976, p. 301-308. 6 refs. NSF Grant No. AER-74-08566.

The long-term performance of a residential solar heating system which has been operating continuously since 1957 with no maintenance was determined during the 1959-1960 heating season and again during the 1974-1975 season. The data obtained during the two heating seasons are compared in the present paper so that changes in efficiency occurring over a 15-yr period can be observed. The design and characteristics of the solar collector are described, it is noted that the most troublesome problem with the system has been air leakage (particularly in the collector), and a performance comparison is carried out. It is found that the amount of useful collected solar heat has declined by 28.2% in 15 yr. F.G.M.

**A76-43181 \*** Solar radiation measurement - Techniques and instrumentation. M. P. Thekaekara (NASA, Goddard Space Flight Center, Greenbelt, Md.). (*International Solar Energy Society, International Solar Energy Congress and Exposition, University of California, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 4, 1976, p. 309-325. 27 refs.

A general survey is presented of solar radiation measurement, techniques, and instrumentation. The importance of determining the total and spectral irradiance of the sun is examined in the context of the energy crisis and utilization of solar energy. The survey includes the extraterrestrial solar fluxes, their possible variations, problems

relating to energy received by collecting surfaces on the ground, major types of instrumentation, and the radiation scales to which the measurements are referred. The type of insolation data available is reviewed. Alternate techniques of deriving insolation data with high, space-time resolution are discussed with reference to solar energy, conversion requirements. Energy received on the ground can be computed from known values of the extraterrestrial solar spectrum and of the spectral absorption parameters of the atmosphere. Another technique is based on measurements made by meteorological satellites of the cloud-cover and of the solar energy reflected and scattered back to space by the earth-atmosphere system.

(Author)

**A76-43182** Performance of a collector-cum-storage type of solar water heater. R. S. Chauhan (Punjab Agricultural University, Ludhiana, India) and V. Kadambi. (*International Solar Energy Society, International Solar Energy Congress and Exposition, University of California, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 4, 1976, p. 327-335. 10 refs.

The paper evaluates the performance of an inexpensive collector-cum-storage type of solar water heater which eliminates the extra cost of providing an insulated overhead tank for storage, does not use pipes, and is completely free from welded joints. The heater was tested in four different modes of operation over a wide range of climatic conditions. The energy loss from the collector is calculated, the storage characteristics of the heater are described, and a theoretical hourly rise in water temperature is computed. In the tests, no appreciable difference in collection efficiency was observed under natural-convection conditions and water circulation with a small pump, showing that additional mixing by outside sources is of little consequence. A collection efficiency as high as 72% was obtained with a mass-flow rate of 75.9 kg/hr; the computed hourly rise in water temperature is found to be within 2.64% to 3.81% of experimentally measured values for absorber-plate temperatures in the range from 30 to 86 C.

F.G.M.

**A76-43183** Dual-mode operation by solar energy of an ammonia-water two-stage cycle - A comparative study. J. C. V. Chinnappa and H. A. Martin (Papua New Guinea University of Technology, Lae, Papua New Guinea). (*International Solar Energy Society, International Solar Energy Congress and Exposition, University of California, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 4, 1976, p. 337-342. 10 refs.

The paper examines a multistage ammonia-water absorption system which operates in a single-stage resorption cycle below a predetermined insolation rate and in a two-stage cycle above that rate. The cooling load of a house of standard construction in Papua New Guinea is computed; the cooling effect produced by the present system is compared with this load and also with the performance of a conventional LiBr unit. It is found that the examined system could meet the cooling demand on a day when the total insolation was about 5360 mW h/sq cm and that the collector area for a LiBr unit with the same capacity must be about 40% greater. Some design problems of the two-stage ammonia system are discussed.

F.G.M.

**A76-43185** A solar thermoelectric refrigerator. G. J. Vella, L. B. Harris, and H. J. Goldsmid (New South Wales, University, Kensington, Australia). *Solar Energy*, vol. 18, no. 4, 1976, p. 355-359.

It is shown that a thermoelectric generator, which draws its heat from the sun, is a particularly suitable source of electrical power for the operation of a thermoelectric refrigerator. The theory of the combined thermoelectric generator and refrigerator is derived, and the ratio of the numbers of thermocouples needed for the two devices is determined. It is found that this ratio can, in principle, be as low as unity, even for unconcentrated solar radiation, though practical considerations indicate that a ratio of 4:1 is preferred in this case. A four-couple thermoelectric generator has been used to power a single-couple refrigerator. Temperatures below 0 C have been achieved for a temperature difference across the generator of about 40 K.

(Author)

**A76-43186** The contribution of solar gain to space heating. M. G. Davies (Liverpool, University, Liverpool, England). (*International Solar Energy Society, International Solar Energy Congress and Exposition, University of California, Los Angeles, Calif., July 28-Aug. 1, 1975.*) *Solar Energy*, vol. 18, no. 4, 1976, p. 361-367. 12 refs. Research supported by the Ministry of Public Buildings and Works.

A school near Liverpool, U.K., is heated by solar radiation and heat from the lighting and the occupants; no conventional heating is used. General reasoning suggests that it should be advantageous to employ solar heat in this locality in winter. Constructional features associated with the solar design are discussed. The results of an observational study suggest that temperatures of 16 C and above can be achieved in winter; daily mean air temperatures of up to 24.5 C are found in summer, with higher peak values. Serious overheating has occurred but is rare. The heating costs appear to be low compared with some other secondary schools. User study findings are reported. While shortcomings in this project are noted, it is concluded that the principle of using solar gain to heat buildings is practical and economical.

(Author)

**A76-43198** Australia takes new look at tidal energy. W. E. Scott. *Energy International*, vol. 13, Sept. 1976, p. 41-43.

The potential for tidal power generation on the Kimberley coast in Western Australia containing nearly all of the country's potentially exploitable tidal energy is discussed. The region is characterized by a tidal range of between 9 and 12 m and the presence of numerous sites suitable for damming. It lacks, however, a nearby energy market. The tidal characteristics and energy potentials are presented for the main Kimberley sites: Secure Bay, Walcott Inlet, George Water, and St. George's Basin. The Australian approach to reduce the dam construction costs is analyzed, noting the selection of the floating caisson method. Three types of structures would be used: six turbine caissons, four sluice gate caissons, and four abutment caissons. Further investigations will concentrate on reducing the turbine generator costs.

S.N.

**A76-43245** Hydrogen from water and sun (De l'hydrogène avec de l'eau et du soleil). J. Rondest. *La Recherche*, vol. 7, Sept. 1976, p. 773. 6 refs. In French.

Recent U.S. experimental studies are discussed concerning utilization of solar energy in producing hydrogen from water. The tris (2,2'-bipyridine) ruthenium (2 plus), provided with two hydrophobic 'queues' is found to be a catalyst capable to dissociate water into hydrogen and oxygen upon exposure to sunlight or ultraviolet radiation. The process is based on the photo-induced electron transfer, excited molecules of the catalyst being at the same time donors and acceptors of electrons. The efficiency of the light to chemical energy conversion based on the absorption of energy quanta is 5.6 to 25 per cent. In other experiments water has been dissociated by using photosynthesis capabilities of some biological species (*Rhodospseudomonas capsulata* bacteria or chlorophyll) or by means of a photo-induced electrolysis of water, using light-sensitive TiO<sub>2</sub> or CdS electrodes.

S.N.

**A76-43246** # Optimization of some eco-energetic systems (Optimizarea unor sisteme energetico-ecologice). I. Purica, M. Pavelescu (Academia Roma, Institutul de Fizica Atomica, Bucharest, Rumania), and M. Stoica (Grupul Scolar Chimic nr. 1, Bucharest, Rumania). *Studii si Cercetari de Fizica*, vol. 28, no. 8, 1976, p. 755-761. 7 refs. In Rumanian.

In this paper we solve an optimization problem of two eco-energetic systems. The first one is close to the actual eco-energetic system in Rumania, while the second is a new one, based on nuclear energy as primary source and hydrogen energy as secondary source. The optimization problem solved is to find the optimal structure of the systems so that the objective functions adopted, namely unitary energy cost C and total pollution P, to be minimum at the same time. The problem can be modeled with a

bimatrix cooperative mathematical game without side payments. We demonstrate the superiority of the new eco-energetic system.

(Author)

**A76-43373 Meteorology and energy - Evaluation of the solar 'deposit' (Météorologie et énergie - L'évaluation du 'gisement' solaire).** C. Perrin de Brichambaut (Météorologie Nationale, Paris, France). *La Météorologie*, June 1976, p. 129-158. 17 refs. In French.

The paper condenses and graphically represents current knowledge concerning world energy resources in the form of solar radiation. A graphical method permits estimation of daily incident energy available to collecting surfaces on the basis of total solar irradiation time. Long-wave terrestrial radiation and evaporation are examined in order to shed light on the thermodynamic generators of meteorological phenomena.

P.T.H.

**A76-43423 Energy impacts on public policy and administration.** Edited by W. F. Scheffer (Oklahoma, University, Norman, Okla.). Norman, Okla., University of Oklahoma Press, 1976. 247 p. \$4.95.

The energy problem in the perspective of time is considered along with the factors affecting energy resources and public policies, the role of government in energy policy, and future policy directions. Attention is given to the nature of the energy problem, the competitive market structure and performance in the petroleum industry, mineral issues and the public interest, energy impacts on domestic and international priorities and policies, congressional initiatives in energy policy, the national energy policy, the role of the state in energy, and the problem of policy-making in energy resource management.

G.R.

**A76-43425 The basics of applied geothermal engineering.** E. F. Wehlage. West Covina, Calif., Geothermal Information Services. 221 p. 85 refs. \$25.

The characteristics of geothermal manifestations are considered along with the structures of the ocean floors, the movement of tectonic plates in relation to the origin of geothermal heat, and the utilization of geothermal heat in various countries. Attention is also given to basic mechanical and electrical facts for geothermal engineering, questions of elementary hydraulics and pumping, methods of heat transfer, the application of steam, geothermal hydroponics, the design of a geothermal dairy, the geothermal prime movers for power production, design procedures for geothermal house heating, and cooling with geothermal refrigeration.

G.R.

**A76-43448 Energy. Volume 3 - Nuclear energy and energy policies.** Edited by S. S. Penner (California, University, La Jolla, Calif.). Reading, Mass., Addison-Wesley Publishing Co., Inc., 1976. 749 p. \$28.50.

Nuclear fission energy is considered with emphasis on the development of pressurized water reactors, boiling water reactors and high temperature gas cooled reactors, and breeder reactors are examined in detail. Controlled fusion is discussed with attention paid to types of magnetic confinement, and the stability and transport properties of confined plasmas. The environmental aspects of nuclear power applications are considered, with discussions of accidents involving nuclear fission reactors, radiation protection standards, nuclear waste disposal and estimates of environmental and safety aspects of fusion power. A section is devoted to energy policies, examining the global impact of energy use, energy conservation and solar heating and cooling.

B.J.

**A76-43464 Energy - The U.S. at the crossroads.** *Environmental Science and Technology*, vol. 10, Sept. 1976, p. 854-859.

Energy policy is discussed in relation to the development of renewable energy sources. Emphasis is on solar energy technology, with discussions also of ocean thermal, tide and wind power. Economic factors associated with the development of renewable sources are examined.

B.J.

**A76-43465 How trash is being turned into useful heat.** *Environmental Science and Technology*, vol. 10, Sept. 1976, p. 860, 861.

The paper describes the pyrolytic waste disposal system of the John Deere Horicon Works. The trash of the company is burned in the pyrolytic system, generating a combustible gas in the primary combustion chamber. Enough heat is generated to save more than 14.6 million cu ft of natural gas annually, and emissions are far below air pollution control standards.

B.J.

**A76-43466 How to put waste heat to work.** C. C. Coutant (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Environmental Science and Technology*, vol. 10, Sept. 1976, p. 868-871. 5 refs.

The utilization and management of waste heat from power plants is discussed. Cooling systems such as cooling towers are shown to pose certain environmental and ecological problems which make the development of waste heat utilization systems urgent. Impact analyses of (including ecosystem analysis) the effects of power plants on the environment point the way to waste heat utilization.

B.J.

**A76-43549 # Supplying the nonindustrial sphere with fuel and energy in the sixth five-year plan (Zasobovani nevyrobní sfery palivy a energií v 6. pětiletce).** V. Vesely (Federalni Ministerstvo Paliv a Energetiky, Prague, Czechoslovakia). *Energetika*, vol. 26, July 1976, p. 301-304. In Czech.

The paper presents some data on the planned fuel and energy budget of Czechoslovakia for the years 1976-1980, with special attention given to the nonindustrial sphere. A percent breakdown of the various types of energy sources used in nonindustrial purposes is given. Directives for fulfilling demand for mined coal, black coal, coke, coal-gas, natural gas, propane-butane, fuel oil, electrical energy, and centralized heat are discussed.

P.T.H.

**A76-43550 # Effect of certain factors on economic assessment of hydroelectric and pumping hydroelectric power plants (Vplyv niektorých základných činiteľov na ekonomické hodnotenie vodných a prečerpávacích vodných elektrární).** S. Hromada (Vyskumny Ustav Energeticky, Bratislava, Czechoslovakia). *Energetika*, vol. 26, July 1976, p. 309-314. 5 refs. In Slovak.

The paper reports on a computer study investigating the effects of construction schedule and turbine installation schedule, on returns and profit rates of pumping hydroelectric power plants. Two pumping hydroelectric plants planned for construction in Czechoslovakia are considered. Various construction and funding schedules were studied by mathematical modeling of their effects on costs, returns, and profits during the projected 50 years of operation for the two plants.

P.T.H.

**A76-43795 Achievements of Electricité de France in the field of tidal power engineering (Les réalisations d'Electricité de France concernant l'énergie marémotrice).** R. Bonnefille (Electricité de France, Direction des Etudes et Recherches, Paris, France). *La Houille Blanche*, no. 2, 1976, p. 87-149. 148 refs. In French.

The basic principles and historical development of tidal power plants are examined, along with the main characteristics of existing designs (single-action and double-action cycles, cycles with and without pumping, two-basin plants). The discussion covers criteria for selecting an appropriate site for a tidal plant; a method of evaluating the natural energy of a site; the location of the areas on earth suitable for plant construction; and data on existing and projected plants in France, Great Britain, USA, USSR, Canada, and Argentina. Detailed attention is given to the description of the French La Rance tidal plant (0.24 GW, 500 GWh/yr) operating since 1966, including the design and characteristics of its axial-flow turbogenerator, anticorrosive protection, principles of operation, methods of calculating plant elements, and technological and economical performance of the plant. Electricité de France research, project design and implementation programs completed to date for the Chausey Islands (Mont-Saint-Michel) tidal plant project (10-12 GW, 20-30 TWh/yr) are analyzed. Data are included on the Les Minquiers plant project (3.9 GW).

S.N.

**A76-44025 #** Geothermal heating including group heating in Rotorua. R. J. Shannon (Ministry of Works and Development, Hamilton, New Zealand). *New Zealand Energy Journal*, vol. 49, June 25, 1976, p. 86-88.

Various aspects of the development of heating systems utilizing geothermal hot water from the geothermal field at Rotorua, New Zealand are examined. The harnessing of geothermal heat, heat exchangers, control valves, and the disposal of thermal waters are among the topics discussed. Also considered are district heating, factors influencing geothermal systems (mineral deposits in pipes and corrosion) and economic aspects. B.J.

**A76-44210** Hydrogen storage electrodes and hydrogen transfer cells. F. A. Lewis, J. N. A. Bell, W. F. N. Leitch (Belfast, Queen's University, Belfast, Northern Ireland), A. Obermann (Hamburg, Universität, Hamburg, West Germany), and R. V. Bucur (Institute for Stable Isotopes, Cluj, Rumania). *International Power Sources Symposium Committee, International Power Sources Symposium, 10th, Brighton, England, Sept. 13-16, 1976, Paper. 9 p.* 31 refs. Research supported by the Science Research Council.

The role of metals and intermetallic compounds capable of rapidly absorbing and desorbing hydrogen seems likely to become increasingly important in regard to the storage of hydrogen produced by electrolysis and its subsequent use in electrochemical cells. Some features of possible hydrogen storage electrodes are discussed with reference to experimental problems and to recent information in related areas of study. (Author)

**A76-44213** High-energy long-life zinc battery for electric vehicles. O. von Krusenstierna (AGA Innovation Centre, Taby, Sweden). *International Power Sources Symposium Committee, International Power Sources Symposium, 10th, Brighton, England, Sept. 13-16, 1976, Paper. 15 p.* 39 refs.

A secondary nickel-zinc traction battery for electric vehicles has been developed with energy densities at the 2-h rate of 45-65 Wh/kg, depending on the choice of nickel cathodes. A lifetime of more than 1000 cycles has been experimentally obtained with a 6-cell 2-kW battery, and the zinc dendrite problem has been solved to such an extent that the nickel cathodes seem to be the life-determining part of the cell. Traction cells in sizes up to 350 Ah have been developed and tested successfully, and energy densities up to 80 Wh/kg seem possible in a well-optimized cell construction. Electric vehicles with this type of high-energy long-life zinc battery will have a range of at least double that which can be reached with a modern lead-acid traction battery. (Author)

**A76-44223** A high energy density molten anode thermal battery. G. C. Bowser, D. Harney, and F. Tepper (Catalyst Research Corp., Baltimore, Md.). *International Power Sources Symposium Committee, International Power Sources Symposium, 10th, Brighton, England, Sept. 13-16, 1976, Paper. 10 p.* 5 refs.

High-specific-energy lithium-calcium chromate cells have been studied both individually and in a thermal battery array. In such cells, the anode material is completely molten, whereas previous thermal cells using calcium have depended upon in situ and sometimes uncontrollable formation of molten alloy to support reasonable current densities. The molten-lithium anode cells contain lithium in a semisealed anode cup with asbestos fibers as a seal and separator. The resulting lithium/lithium chloride-potassium chloride/calcium chromate cells yield anode efficiencies up to 60%. Using a Cr(6+) to Cr(3+) reduction equation as a basis, cathode efficiencies as high as 66% (to 1.5 V) and 92% (to 0 V) have been obtained. Battery tests show a number of advantages over earlier thermal battery cells, including a wider operational temperature range, noise, reduction, and increase in energy density by 100-200%. Single-cell and battery data are compared and show good correlation. (Author)

**A76-44225** H<sub>2</sub>/O<sub>2</sub> fuel cell assemblies with higher power densities. H. Grüne, H. B. Gutbier, and K. Strasser (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *International*

*Power Sources Symposium Committee, International Power Sources Symposium, 10th, Brighton, England, Sept. 13-16, 1976, Paper. 24 p.* 11 refs. Research supported by the Bundesministerium für Forschung und Technologie.

In recent years, a series of H<sub>2</sub>/O<sub>2</sub> fuel-cell assemblies with alkaline electrolyte have been constructed and tested. Based on the results obtained and with a view toward increasing the power density, a 7-kW compact assembly was developed which yielded (without the recooling of the circulating water) power ratios of approximately 10 kg/kW and 8 l/kW, respectively. The main feature of this construction is the integration of all auxiliary units necessary for the autogeneous operation into a module. The assembly essentially comprises a fuel-cell battery, an electrolyte regenerator, and a monitoring device as the functional units. The battery contains 70 cells switched in series and can be loaded with about 400 mA/sq cm at 80 C when operating with hydrogen and oxygen. Raney-nickel (anode) and doped silver (cathode) are used as catalysts. The water of reaction formed and the heat losses from the circulating electrolyte are removed in the electrolyte regenerator. (Author)

**A76-44227** Batteries for bulk energy storage on the U.K. Electricity Supply System. A. B. Hart and A. H. Webb (General Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England). *International Power Sources Symposium Committee, International Power Sources Symposium, 10th, Brighton, England, Sept. 13-16, 1976, Paper. 15 p.* 23 refs.

A wide range of rechargeable electrochemical batteries is reviewed as possible bulk energy storage units on the U.K. Electricity Supply System. The annual capital charges of the various batteries are estimated. It is shown that none of the present commercially available batteries can meet the break-even target of about 30 pounds sterling/kW output per annum. Among the 'advanced' systems, sodium-sulphur and possibly lithium-chlorine and aluminium-chlorine show promise of costs below the target if the development problems can be inexpensively overcome. The iron-air, zinc-chlorine, and lithium-sulphur systems are estimated to cost slightly more than the target, but are being actively developed, and costs might be reduced. Redox systems also look promising on cost grounds but have a low-volume energy density which presents some siting problems. (Author)

**A76-44495** Summary of results of the I.C.F. seminar held on March 4, 1976 (Essai de synthèse des résultats de la journée I.C.F. /4 Mars 1976/). R. Gibrat. *Sciences et Techniques*, Sept. 1976, p. 7-11. In French.

The paper reviews the results of the seminar on tidal energy utilization organized by the Société des Ingénieurs Civils de France (I.C.F.). The studies on the tidal power problems carried out in Canada are discussed. Detailed attention is given to the basic theoretical problems concerning conditions of validity and accuracy of the existing mathematical models (two-dimensional models, numerical calculations, boundary conditions, importance of various tidal components). The seminar has proven the technical feasibility of the Chausey project (France), the advantages of mass production of 40 or 50 MW generators for tidal power plants, the high reliability of the La Rance plant systems. The analysis of operational difficulties of the La Rance turbine proved the successful evolution of the bulb type turbines toward high power outputs. Further major research is necessary however, in order to determine the influence of the dam and the plant on the tidal regime, and to calculate energy cycles for different tidal plant models. S.N.

**A76-44496** Calculation of energy output and financial returns of tidal power plants (Les calculs d'énergie ou de recettes des usines marémotrices). R. Gibrat. *Sciences et Techniques*, Sept. 1976, p. 12-14. In French.

The progress, current state of the art, and prospects of the energy calculation methods for tidal plants are examined. The case of 27 tides (14 days) is selected as corresponding to the real problem of exploitation cycles. A differential equation technique was developed for early plants, which made it possible to optimize the energy production. In the calculations for the La Rance plant (complicated

by the existence of valves, water level and velocity limitations) the Bellmann dynamic programming method was used, based on the assumption that the water level in the tidal basin is horizontal or that level variations can be allowed for by simple approximations. This assumption become insufficiently accurate for the large projects now under study (Chausey, Bay of Fundy). A new approach is described, based on the Pontriagin's method, in which the system (sea, dam, and tidal basin) is treated as an entity. S.N.

**A76-44497** Tidal power plants in Argentina (Les usines marémotrices en Argentine). R. Gibrat. *Sciences et Techniques*, Sept. 1976, p. 15-17. In French.

The development of tidal energy exploitation projects in Argentina is discussed in the light of recent technological and economic studies. The main tidal power plant project (Valdez Peninsula) involves the digging of a 7 km canal in order to use the exceptional difference in tidal phase between two gulfs. The analysis covers: calculations of tidal regime, technical and economic problems concerning the excavation works, and evaluation of the economic value of the energy. Theoretical problems specific for this site due to different tidal resonances are indicated. The theory of tidal oscillation in ports appears to be at least partially applicable. Use of nuclear excavation may offer considerable economy. The necessity of a detailed hydrographic survey to advance the project is pointed out. S.N.

**A76-44498** Prospects for the controlled thermonuclear fusion (Perspectives de la fusion thermonucléaire contrôlée). C. Ruhl (Lyon I, Université, Lyons, France). *Sciences et Techniques*, Sept. 1976, p. 18-24. 6 refs. In French.

The state of the art and major trends in solving the problems of controlled thermonuclear fusion are reviewed. Basic principles of nuclear fusion reactions and conditions necessary to use D plus T equals He plus n reaction for energy production are considered. Two major current approaches are discussed: (1) heating of deuterium droplets by laser, and (2) adiabatic compression of a plasma contained within an electromagnetic field (Tokamak project). The design and main characteristics of the French Tokamak TFR which has achieved the temperature of 23,000,000 K are described. The project JET (Joint European Torus) Tokamak (radii of the toroidal chamber 2.70 and 1.35 m; magnetic field in the chamber 3 teslas, plasma current 3,000,000 A) might achieve the required ignition temperature of 230,000,000 K by 1980. S.N.

**A76-45076 #** Thermonuclear fusion as an energy source - The outlook for its practical use (Termoiadreniiat sintez kato iztochnik na energiia - Perspektivi za praktichesko izpolzuvane). E. Dzhakov. *B'lgarska Akademiia na Naukite, Spisanie*, vol. 22, no. 2, 1976, p. 38-48. In Bulgarian.

The state of the art in the development of thermonuclear power plants for generating (electrical) power is reviewed, with emphasis on thermonuclear reactors utilizing laser bombardment of deuterium-tritium pellets. Traditional thermonuclear facility designs (Tokamaks, mirror machines, plasma confinement configurations) are reviewed, with discussion of energy losses, plasma heating, instabilities, conditions for attaining sufficient product of number of interacting particles and confinement time. The advantages of Mo and Nb as wall materials, the function of a Li blanket, and advantages of laser irradiation of fuel pellets are discussed, and a schematic diagram of a fusion electric power station is presented. Inexhaustibility of the fuel and nonpollution of the environment are underscored. R.D.V.

**A76-45226** Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Edited by R. F. Hill (Federal Power Commission, Washington, D.C.). Washington, D.C., Government Institutes, Inc., 1976. 345 p. \$25.

The proceedings are organized in four parts: policy, new technology, constraints on application of energy technology and prospectus. The kinds of technology considered are fission, fusion, energy storage, fossil fuel, synthetic fuels, coal gasification, energy conservation, geothermal, solar, photovoltaics and biomass utilization, hydrogen, fuel cell and wind. The constraints of energy technology application discussed are natural resources availability, the carrying capacity of the environment and legal issues. B.J.

**A76-45227** Commercialization of new energy technology. W. T. Slick, Jr. (Exxon Co., Houston, Tex.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 9-16.

Some general concepts on the roles of government and industry in energy research and development are outlined, with emphasis on problems of economics, regulation, and environment. These general concepts are illustrated with reference to energy technology development in the fields of conventional oil and gas, and synthetic fuels. B.J.

**A76-45228** New technology - Look ahead to utilization. C. G. Kirkbride (ERDA, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 17-23.

The development of new energy technology is examined with reference to the development of the technological economy in the United States over the past 200 years. The development of crude oil and natural gas technologies is discussed, together with the roles of ERDA and FEA in such development and the commercialization of energy technology. B.J.

**A76-45229** Fission technology. R. W. Roberts (ERDA, Div. of Nuclear Energy, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 25-33.

The paper examines the role of ERDA in the development of nuclear power plant technology. Attention is paid to the nuclear fuel cycle, environment effects, the Clinch River Breeder Reactor demonstration project, and to the work of the Division of Nuclear Research and Application which treats advanced technology such as space/nuclear systems. B.J.

**A76-45230** Status and future directions of fusion power research and development. R. L. Hirsch (ERDA, Div. of Solar, Geothermal and Advanced Energy Systems, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 34-52.

The basics of nuclear fusion are reviewed, and the major approaches to fusion power research are discussed. Attention is given to existing confinement experiments (ORMAK, ATC, and the 2X-IIB at Lawrence Livermore Laboratory), and to future confinement experiments and reactors (the Princeton large torus, and the Tokamak Fusion Test Reactor). Laser fusion is discussed. B.J.

**A76-45231** Energy storage. J. A. Casazza, T. R. Schneider, and V. T. Sultzberger (Public Service Electric and Gas Co., N.J.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 53-67. 7 refs.

Results of an ERDA/EPRI study on the effects of energy storage on utility oil requirements are presented. The role of energy storage in energy research and development is examined with

attention given to utility systems analysis objectives, the amount and distribution of on-peak and off-peak energy, duty cycle requirements, and supportable power capacity. An economic analysis of energy storage is performed, and existing energy storage technologies are evaluated. B.J.

**A76-45232 Fossil fuel technology.** P. C. White (ERDA, Div. of Fossil Energy, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 68-74.

Strategy for the ERDA Fossil Energy Program is reviewed. The basic objectives of the program are: (1) to increase coal utilization, (2) to recover oil still remaining in known depleted reservoirs, (3) to evaluate the potential of oil shale resources, (4) to extract oil and shale from currently uneconomic and inaccessible resources, and (5) to develop synthetic fuels on the basis of fossil resources. B.J.

**A76-45233 Synthetic fuels in perspective.** D. H. Clewell (Mobil Oil Corp., New York, N.Y.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 75-83.

It is clearly in the national interest to develop a commercial synthetic-fuels industry in the United States in order to help prepare for the day when the worldwide production of conventional oil and gas will be unable to meet the demand. It is expected that by 1990, synfuels will be a small but growing industry, contributing some 2.5% to the nation's total energy needs. At present, synfuel costs are not competitive with other energy sources. Many additional problems remain to be solved in the areas of technology, environmental concerns, water availability, lack of infrastructure, and capital accumulation. (Author)

**A76-45234 Coal gasification.** J. R. Rensch (Pacific Lighting Corp., Los Angeles, Calif.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 84-90.

The implementation of high Btu coal gasification technology in the United States is examined with emphasis on programs for second generation technology and the advantages of proceeding now to the commercial plant stage. The pioneer WESCO gasification project in northwest New Mexico is discussed in detail. Economic factors are considered including the cost of delays, financing, the concerns of lenders and the necessity of loan guarantees for early plants. B.J.

**A76-45235 Energy conservation - Government-industry efforts.** J. B. Roose (FAA, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 96-102.

The paper discusses the Energy Policy and Conservation Act. Overriding goals of government-industry energy conservation activities are examined including: (1) the identification of the conservation potential within each of the major energy consuming industry groups, (2) the identification of constraints on industry's ability to reduce energy demands, (3) data collection to inform the public of progress in industrial conservation, and (4) identification, and development of government and industry policy initiatives. B.J.

**A76-45236 Hydrothermal geothermal resources and growth in utilization.** P. N. La Mori (Electric Power Research Institute, Palo Alto, Calif.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 103-114.

The paper examines vapor dominated and water dominated hydrothermal convection energy systems from the points of view of

growth in utilization, environmental problems and financing. The distribution of hydrothermal convection systems is examined with a histogram presented of the number of thermal springs vs temperature. Geothermal power production from convection systems is estimated. B.J.

**A76-45237 ERDA's geothermal R&D program.** E. H. Willis (ERDA, Div. of Geothermal Energy, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 115-128.

The paper examines the objectives, problem areas, program strategy, and priority criteria for the ERDA geothermal energy program. The sources considered are hydrothermal, geopressurized and hot dry rock. The program elements considered are: resource exploration and assessment, hydrothermal technology applications, advanced technology applications, environmental control and institutional studies, engineering research and development, and loan guaranty. B.J.

**A76-45238 Solar energy and the ERDA plan for research, development and demonstration.** H. H. Marvin (ERDA, Div. of Solar Energy, Washington, D.C.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 129-134.

The ERDA solar energy program is discussed. Attention is paid to solar heating and cooling, process heat, wind energy conversion, solar thermal conversion, photovoltaic energy conversion, ocean thermal energy conversion, and biomass energy conversion. B.J.

**A76-45239 \* Large experimental wind turbines - Where we are now.** R. L. Thomas (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 135-157. 12 refs.

Several large wind turbine projects have been initiated by NASA-Lewis as part of the ERDA wind energy program. The projects consist of progressively large wind turbines ranging from 100 kW with a rotor diameter of 125 feet to 1500 kW with rotor diameters of 200 to 300 feet. Also included is supporting research and technology for large wind turbines and for lowering the costs and increasing the reliability of the major wind turbine components. The results and status of the above projects are briefly discussed in this report. In addition, a brief summary and status of the plans for selecting the utility sites for the experimental wind turbines is also discussed. (Author)

**A76-45240 Photovoltaics and biomass utilization.** A. C. Johnson (Mitre Corp., Bedford, Mass.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 158-162.

The direct conversion of sunlight into electricity by photovoltaic cells, and the production of heat or fuels from organic wastes or from land or water crops grown for energy purposes, are two applications of solar energy which offer considerable promise for the midterm. Research, development and demonstration can produce more efficient and reliable photovoltaic systems and better production methods; more efficient biomass production, collection and conversion processes; and optimized systems for the utilization of both these energy sources. (Author)

**A76-45241 An industry view of solar heating and cooling.** R. N. Schmidt (Honeywell, Inc., Minneapolis, Minn.). In: Energy technology III: Commercialization; Proceedings of the Third Con-

ference, Washington, D.C., March 29-31, 1976.

Washington, D.C., Government Institutes, Inc., 1976, p. 163-171.

A brief review is presented of the status of solar heating and cooling in the United States. Discussions are presented on the need for economical solar systems and on the need for further research and development. The development of solar power plants is also discussed. B.J.

**A76-45242 Hydrogen energy technology - Update 1976.** J. B. Pangborn and D. P. Gregory (Institute of Gas Technology, Chicago, Ill.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 172-182. 47 refs.

A number of hydrogen production techniques are discussed including thermochemical hydrogen production, hydrogen from the reaction of coal and steam, water electrolysis, and photosynthetic and photochemical hydrogen production. Hydrogen storage, transmission, distribution, and materials compatibility with hydrogen in storage and transmission systems are also considered. Hydrogen utilization is examined with attention given to automotive, aircraft and industrial applications. B.J.

**A76-45243 Fuel cells for utility service.** W. J. Lueckel, Jr. and J. R. Casserly (United Technologies Corp., Power Systems Div., Hartford, Conn.). In: Energy technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 183-194.

The paper reviews progress in the development of commercial fuel cell power plants for electric power generation. Attention is given to fuel cell characteristics and applications (electric utility applications, on-site applications, integrated energy systems, and future applications). Fuel cell programs are reviewed including the Electric Utility Fuel Cell Program, the EPRI RP114 Program, and the TARGET program. The future outlook of fuel cell power plant development is examined with emphasis on fuel availability and investment requirements. B.J.

**A76-45244 Energy-oriented R&D at EPA.** S. J. Gage (U.S. Environmental Protection Agency, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 201-218.

The paper focuses on environmental control technologies being developed to avoid and prevent harmful effects of the expanded use of domestic coal. These efforts are discussed in terms of post-combustion, combustion, and pre-combustion control technologies. Post-combustion technologies examined include flue-gas desulfurization, particulate control, and NOx removal. Combustion technologies described include combustion modification to reduce NOx emissions and fluidized-bed coal combustion. The pre-combustion technologies refer to coal cleaning so that medium- and (possibly) high-sulfur coals can meet present sulfur dioxide emission standards. Other areas noted include technologies for extracting energy from municipal solid waste, for producing synthetic fuels, and for developing advanced power and energy systems. F.G.M.

**A76-45245 Natural resources availability.** W. L. Fisher (U.S. Department of the Interior, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 220-225.

The principal question addressed in this paper is whether increased energy production to attain energy independence would be constrained by an inadequate supply of minerals necessary to produce the energy. To answer this question, scientists were set to work to identify and project the quantity of each basic nonfuel material needed by the energy industries between 1975 and 1990, to review the domestic reserves and resources of the commodities so

identified, to study their geological availability abroad, to evaluate U.S. demands compared to the adequacy of domestic resources, alternative sources of supply, and such factors as the availability of substantial materials. It was also sought to determine the material whose shortage might become a problem. In the final analysis, it is felt that the ability to implement new energy technologies will not be constrained by any shortage of any natural resource, but that a long and difficult job lies ahead to provide these natural resources in the amounts needed at the times they will be needed. V.P.

**A76-45246 World energy prices and their impacts on new technology.** J. P. Henry, Jr. (Stanford Research Institute, Menlo Park, Calif.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 232-244.

The economic climate for the development of new energy technologies is discussed. It is argued that there will probably be a worldwide excess of producible energy by the year 2000 and that the current price of energy may well be too high. A brief analysis of the worldwide petroleum trade by the year 2000 is presented, showing that total United States oil imports at that time will be about the same level as in 1975 and that Middle East oil exports will probably be demand-limited for at least 25 years. World trade in natural gas and coal is also discussed, and it is predicted that nuclear power will probably account for 20% of the world energy supply by the end of the century. It is concluded that the world supply of conventional fuels remains large and that energy prices may stabilize in the 1980s. F.G.M.

**A76-45247 Constraints on utilization of energy resources.** J. N. Nassikas (Cox, Langford and Brown, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 245-269. 28 refs.

Currently existing constraints on the adoption and enforcement of energy policies are examined. The aims of these policies are to conserve energy by its more efficient utilization in a productive economy, to replace our current reliance on nonrenewable fossil-fuel resources by new inexhaustible environmentally acceptable energy forms and technologies, and to create, by research and development, renewable energy resources. The current and perspective utilization of energy sources is reviewed, along with the current production and import trends for oil, natural gas, and coal; and the trends in electric power generation from nuclear power plants. The major constraints on increasing domestic production of oil, natural gas, and coal are discussed. V.P.

**A76-45248 Financing tomorrow's energy systems.** R. L. Golden. In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 270-278.

The financial constraints currently placed on the application of energy technology are discussed. It is pointed out that tomorrow's energy needs must be satisfied by maximum utilization of our domestic natural, technological, and financial resources. To fail to do this would be much more harmful to the future of our country than the most extreme forms of action on the part of the Organization of Petroleum Exporting Countries. The capital to carry out energy projects is more readily available in the United States than in any other part of the world, provided the means, in the form of top credit quality backing, is available. Those means, in the form of oil majors and electric utility sponsors, are currently being jeopardized by a potentially explosive mixture of confused political debate and regulation which is slow to respond to present-day economic realities. Sponsors of tomorrow's needed well-structured energy projects must be provided greater, not less, access to the capital pool. Burning rather than strengthening their bridges to the capital market will make 'Project Independence' a joke. V.P.

**A76-45249** Legal issues in the implementation of new energy technology. F. Moring (Morgan, Lewis and Bockius, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 279-285.

The complex relationship between the Federal Government, consumer rights and states' rights in establishing an energy technology is outlined, and the restraints placed by consumer and states' rights on the technology are demonstrated. The need for a new set of trade-offs between the consumers' interests, environmental interests, and the states interests is indicated. V.P.

**A76-45250** A systems approach to energy/environmental analysis. M. I. Singer (ERDA, Office of Commercialization, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 287-306. 5 refs.

The studies discussed were sponsored by the Council on Environmental Quality in support of its roles in energy/environmental policy analysis and environmental impact statement coordination. Specifically, three analytical tools, sponsored by CEO, EPA, and ERDA, are described. The first tool is MERES (Matrix of Environmental Residuals for Energy Systems); the second tool is a comparative analysis, called Energy Alternatives; and the third tool is a regional interfuels competition model which uses an energies systems approach linking resources, conventional processes, and transportation with end use of energy. An example is given, showing how these tools were used to study some choices involved in the development of energy resources in the western United States. V.P.

**A76-45251** Regional energy systems planning. R. F. Hill (Federal Power Commission, Office of Energy Systems, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 307-314.

The problem of how new energy technologies can be utilized to achieve our societal objectives within natural and institutional constraints is discussed. It is seen that the problem can be resolved only by developing a philosophy of regional energy systems planning, which requires the examination of all individual key energy decisions in the context of the interconnections among all closely related decisions. Taken together, all regional energy systems plans will constitute the national energy system plan. V.P.

**A76-45252** New federal initiatives in energy commercialization. W. T. McCormick (ERDA, Office of Commercialization, Washington, D.C.). In: Energy Technology III: Commercialization; Proceedings of the Third Conference, Washington, D.C., March 29-31, 1976. Washington, D.C., Government Institutes, Inc., 1976, p. 322-332.

The Federal effort being made to bring emerging energy technologies into the marketplace is demonstrated by discussing the currently important problem of initiating a synthetic fuels industry in the United States. The challenge facing ERDA in forming a partnership with the industry to proceed with the development of this technology in the face of existing risks and uncertainties is outlined. V.P.

**A76-45289** Progress in chemical vapor deposition of thin silicon films for solar energy conversion. H. S. Gurev and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: International Conference on Chemical Vapor Deposition, 5th, Fulmer, Bucks., England, September 21-26, 1975, Proceedings. Princeton, N.J., Electrochemical Society, Inc., 1975, p. 667-680. 17 refs. NSF Grant No. GI-36731X.

Multilayer systems deposited by CVD offer attractive features.

The paper outlines the characteristics of an absorber-reflector tandem configuration that satisfies the major requirements for a photothermal converter. Preliminary solutions leading to the feasibility of the concept are discussed. Selective absorbers, using CVD films of Si<sub>3</sub>N<sub>4</sub> and Si atop evaporated Ag reflector films, are prepared and shown to display solar absorptance of 75% and a/e values in excess of 12 at 500 C. The selective absorber stacks deposited on austenitic stainless steels are found to retain their mechanical integrity and optical properties after 2000 thermal cycles to 500 C and 20 hr exposure at 625 C. Si films deposited by the pyrolysis of silane in helium at 642 C can be controlled to yield thickness uniformity within + or - 1% across a 5 cm x 5 cm substrate. Silicon deposition economics is discussed in terms of a process efficiency factor called the relative deposition efficiency. S.D.

**A76-45301** Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports (Heizen mit Sonne; Tagung, 1st, Göttingen, West Germany, February 23, 24, 1976, Tagungsberichte). Meeting sponsored by the Deutsche Gesellschaft für Sonnenenergie. Edited by U. Bossel. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976. 378 p. In German. \$13.95.

The prospects and perspectives concerning a utilization of solar energy are examined and the components for solar heating systems are considered, taking into account solar data for Göttingen in West Germany, the design and the characteristics of solar energy collectors, the efficiency of flat solar energy collectors employing selective coatings, questions of system design for heating installations which make use of solar energy, possibilities for the long-term storage of solar energy for the cold season, and the economical fabrication of collectors and heat-storage devices made of plastic materials. Attention is also given to developments related to architecture and solar houses, various applications of solar energy collectors, the economics of solar heating systems, and the work of Swiss and German organizations for the development of solar energy systems. G.R.

**A76-45302** The status and prospects of solar energy (Stand und Aussichten der Sonnenenergie). E. Justi (Braunschweig, Technische Universität, Braunschweig, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 3-34. 19 refs. In German.

It is shown that the amount of solar energy received on earth is more than sufficient to satisfy any conceivable energy requirements of human civilization. Approaches for providing energy with the aid of solar cells have to overcome disadvantages related to the high costs of solar cell production. Thermal approaches requiring a concentration of solar radiation have certain operational disadvantages. Methods utilizing planar radiation collecting devices which do not suffer from these disadvantages are discussed. Attention is given to solar heating in the area of residential housing, solar power stations producing hydrogen as energy carrier in the south of Europe, and the superiority of bioenergetic systems based on photosynthetic reactions. G.R.

**A76-45303** The utilization of solar energy after exhaustion of fossil and mineral energy sources (Nutzung der Sonnenenergie nach Versiegen der fossilen und mineralischen Energiequellen). U. Bossel (Aerodynamische Versuchsanstalt, Göttingen, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 35-60. 15 refs. In German.

The reasons for a utilization of solar energy are examined in connection with the limitations of fossil fuel resources and certain



undesirable environmental effects related to their use. The characteristics of solar energy and its availability are considered along with suitable approaches for utilizing this energy. Attention is given to the direct and indirect utilization of solar heat, the employment of heat buffer systems, indirect methods for electric power generation based on processes caused by solar radiation, the employment of solar cells, problems of energy storage, and bioenergetic approaches. Economical and political considerations related to a utilization of solar energy are also discussed. G.R.

**A76-45305** **Component solar energy collector (Baustein-Solkollektor).** A. Kalt (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Raumsimulation, Cologne, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 81-93. In German.

Approaches for the thermal utilization of solar radiation energy employ a device which absorbs the radiation and transforms it into heat. Problems in the design of suitable 'collectors' are related to the necessity to prevent or reduce a loss of a part of the absorbed energy as a consequence of thermal radiation and conduction processes. A description is given of the various approaches used to reduce the energy losses as much as possible. Attention is given to solar energy collectors which are suitable for operation under the solar radiation conditions existing in West Germany and devices designed by American companies. G.R.

**A76-45306** **The efficiency of flat collectors, giving particular attention to selective coatings (Der Wirkungsgrad von Flachkollektoren unter besonderer Berücksichtigung selektiver Schichten).** R. Köhne (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 95-108. In German.

The radiation absorbed by the surface of a flat solar energy collector is transformed into heat which is carried to the consumer by means of a suitable medium, such as water. The efficiency of the collectors depends to a large degree on the properties of the collector surface. A suitable surface should combine good absorption characteristics for the wavelength region of solar radiation with low emission coefficients for thermal radiation. Approaches for obtaining the desired selectivity properties for the collector surface are discussed. Attention is given to the improvement of the directional selectivity, the use of black chrome as a selective coating, and the employment of a glass plate with a coating of indium oxide. G.R.

**A76-45307** **System design for heating installations which make use of solar energy (Systemschaltungen von Heizungsanlagen mit Verwertung der Sonnenenergie).** H. Krininger (München, Fachhochschule, Munich, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 109-125. 6 refs. In German.

The collector circuit constitutes the most essential part of a heating system which makes use of solar energy. The collector circuit system includes solar energy collectors mounted on the roof, a pump, a heat-storage tank, and connecting pipes. A water-glycol or water-ethylene mixture is recommended for operation under the climatic conditions of West Germany. The design of systems for providing hot water is discussed, taking into account systems in which heating with the aid of solar energy can be supplemented with heating by conventional methods. Attention is also given to systems which utilize solar energy for residential heating applications. A suitable design for a system which employs a heat pump is also considered. G.R.

**A76-45308** **Possibilities for the long-term storage of solar energy for the cold season. (Langzeit-Speichermöglichkeiten der Sonnenenergie für die kalte Jahreszeit).** H. Frees (Wind- und Sonnenenergie Anlagenbau GmbH, Eckernförde, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 127-133. In German.

The possibility is considered to store solar energy received during the summer for the winter season, taking into account the employment of various chemical heat storage systems and the use of water and stones as heat storage medium. A description is given of a solar house heating design which makes use of a long-term heat storage installation. Attention is given to the principles of operation involved, the cost of the heating system, and the savings in operational expenses which are obtained by using such a system in place of a conventional heating system. G.R.

**A76-45309** **Economical fabrication of collectors and heat-storage devices made of plastic materials, their characteristics, and their employment possibilities (Wirtschaftliche Herstellung von Kollektoren und Wärmespeichern aus Kunststoffen, deren Verhalten und Anwendungsmöglichkeiten).** A. F. Böckmann (Krauss-Maffei-Aktiengesellschaft, Munich, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 135-153. In German.

Suitable approaches for utilizing the solar radiation for residential heating applications are examined and a brief description is presented of an investigation which was conducted to study the available quantity of solar energy for such a utilization in various countries of Europe and in Africa. The apparatus used in the studies was subsequently improved. The apparatus includes a solar energy collector. Approaches for the economical fabrication of the collector are discussed, taking into account collectors made of plastics or metal. Operational questions concerning the employment of collectors made of different materials are also discussed. G.R.

**A76-45310** **The 'zero energy house' of the Technical University of Denmark (Das 'Null-Energie-Haus' der Technischen Hochschule von Dänemark).** V. Korsgaard (Danmarks Tekniske Højskole, Lyngby, Denmark). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 175-196. In German.

The reported project has the objective to demonstrate that it is possible to heat a one-family house without the use of conventional fuels, taking into account the climatic conditions of Northern Europe. Hot water can also be provided. The approach employed to obtain this objective requires only the use of the amount of electric energy which is normally consumed in an average household. The approach makes use of a very effective form of thermal insulation and various other methods for reducing the amount of heat which is needed. The reduced heating requirements can be satisfied by the solar energy received and the heat generated in connection with the consumed electric energy. Design details for the zero energy house are discussed. Attention is given to aspects of cooling and heating, heat losses in connection with the exchange of air, and the quantities of heat received from various sources. G.R.

**A76-45311** **The structural design of solar houses represented with the aid of the Austrian solar house as an example (Die bautechnische Gestaltung von Sonnenhäusern dargestellt am Beispiel des Österreichischen Sonnenhauses).** E. Panzhauser (Wien, Technische Universität, Vienna, Austria) and K. Fantl (Österreichisches Institut für Bauforschung, Vienna, Austria). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 197-216. In German.

Solar houses are buildings for which the energy requirements for heating, cooling, and hot water can be satisfied to a very large degree with the aid of the solar energy incident upon the building. Attention is given to a passive utilization of the radiation energy, a semipassive energy utilization, air-cooled collector systems, water-cooled collector systems, the possibility of heliovoltaic energy conversion systems, aspects of structural form, system considerations related to the design of solar houses, and questions of component optimization. The characteristics of buildings suitable for solar heating systems are discussed. The application of the described concepts is illustrated with the aid of specific solar house designs.

G.R.

**A76-45312 Utilization of solar energy and efficient energy employment in buildings (Nutzung der Sonnenenergie und rationelle Energieanwendung in Gebäuden).** R. Bruno, W. Hermann, H. Hörster, R. Kersten, K. Klinkenberg, and F. Mahdjuri (Philips GmbH, Forschungslaboratorium Aachen, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 217-242. In German. Research supported by the Bundesministerium für Forschung und Technologie.

Questions of energy consumption in West Germany are considered along with suitable approaches for reducing the consumption of low-temperature heat. Attention is given to an experimental house which had been constructed to study integrated energy systems with respect to the possibility of their economical implementation under European climatic conditions. The results obtained in the studies are discussed, taking into account efficiency data for solar collectors, the reduction of thermal losses, the employment of heat pump, and the energy of solar radiation.

G.R.

**A76-45313 Collector - Storage device - Optimization (Kollektor - Speicher - Optimierung).** K. R. Schreitmüller (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 275-295. In German.

The development of an optimal design procedure for solar energy collector systems is considered. A description is presented of the design of suitable computational models which can represent the system characteristics with sufficient accuracy and which make it possible to vary the parameters within wide limits. Attention is given to a climatic model, the collector equations, details of hot water supply, and a computational model for the heating systems of buildings.

G.R.

**A76-45314 The use of solar energy - Comparative considerations with respect to hot water supply and the generation of heat and cold (Einsatz von Solarenergie - Vergleichende Betrachtungen bei der Warmwasserbereitung, Wärme- und Kälteerzeugung).** K. Daniels (HL-TECHNIK GmbH, Munich, West Germany). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 297-330. In German.

The use of solar energy in major projects is examined and the current status of technology in the area of solar heating is considered. Hot-water supply systems which are based on a utilization of solar energy are discussed, taking into account system design questions, principles of operation, performance, and an evaluation of the economic factors. A solar heating system for an office building in Albuquerque, New Mexico is described and attention is given to a heating and cooling system which is based on the use of solar energy.

G.R.

**A76-45315 Israeli heliotechnology for Central Europe (Israelische Heliotechnik für Mittel-Europa).** J. Mantel (Dr. Mantel und Partners GmbH, Ingenieurbüro für Akustik, Munich, West Germany and Haifa, Israel). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports.

Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 331-338. 7 refs. In German.

Current concepts concerning the design of solar heating systems for residential housing in Central Europe require for their implementation comparative large investments. It appears, therefore, that heating systems based on these concepts will not be economically competitive. Similar problems have led in Israel to studies intended to develop heating systems with a simpler, less costly design characteristics. An investigation is conducted of the possibility to utilize Israeli advances in the technology of solar heating systems for European applications.

G.R.

**A76-45316 The Swiss association for solar energy after one year - Advances, successes, and prospects concerning solar energy utilization in Switzerland (1 Jahr Schweizerische Vereinigung fuer Sonnenenergie - Fortschritte, Erfolge und Aussichten der Sonnenenergienutzung in der Schweiz).** P. Fornallaz (Eidgenössische Technische Hochschule; Schweizerische Vereinigung für Sonnenenergie, Zurich, Switzerland). In: Solar heating; Meeting, 1st, Göttingen, West Germany, February 23, 24, 1976, Reports. Gräfelfing, West Germany, Deutsche Gesellschaft für Sonnenenergie, 1976, p. 341-353. In German.

**A76-45543 Thermal energy storage; NATO Science Committee Conference, Turnberry, Scotland, March 1-5, 1976, Report.** Edited by E. G. Kovach (NATO, Scientific Affairs Div., Brussels, Belgium). Brussels, NATO, 1976. 84 p.

Papers are presented on the concept of thermal exergy (defined as available energy or latent work), and low and high temperature heat storage systems. Also considered are heat transfer and thermal energy transport in relation to heat storage, and the impact of thermal energy storage on such energy structures as residential, commercial and urban heating systems.

B.J.

**A76-45544 # Thermal exergy and its storage.** J. Koefoed (Danmarks Tekniske Højskole, Lyngby, Denmark). In: Thermal energy storage; NATO Science Committee Conference, Turnberry, Scotland, March 1-5, 1976, Report. Brussels, NATO, 1976, p. 5-10.

The paper is devoted to some of the basic processes of thermal energy or thermal exergy storage, with exergy denoting free energy, available energy, or latent work. The concepts of entropy and temperature are discussed in relation to exergy storage, and chemical means for thermal energy storage are considered.

B.J.

**A76-45545 # High temperature thermal energy storage.** D. E. Elliott (Aston, University, Birmingham, England), T. Stephens (MIT, Lexington, Mass.), M. F. Barabas (Saskatchewan Power Corp., Regina, Canada), J. Bonnin (Electricité de France, Chatou, Yvelines, France), A. Bricard (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Grenoble, Grenoble, France), T. D. Brumleve (Sandia Laboratories, Livermore, Calif.), G. B. DeLancey (Stevens Institute of Technology, Hoboken, N.J.), Ch. A. Kruissink (Central Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, Centraal Laboratorium TNO, Delft, Netherlands), G. A. Lane (Dow Chemical Co., Midland, Mich.), and G. Beckmann. In: Thermal energy storage; NATO Science Committee Conference, Turnberry, Scotland, March 1-5, 1976, Report. Brussels, NATO, 1976, p. 11-26. 11 refs.

The paper examines three types of thermal energy storage: sensible heat storage, latent heat storage and chemical energy storage. Packed beds, fluidized solids, and liquids (pressurized hot water

storage, and organic and inorganic liquids) are considered under the heading of sensible heat storage. Latent heat storage involves solid-liquid phase change materials (inorganic salts or metals) and can be applied to heat engines and power plants, industrial processes, and domestic and commercial heat systems. Catalytic reactions and thermal dissociation reactions are discussed in relation to chemical energy storage. B.J.

**A76-45546 # Low temperature thermal energy storage.** J. W. Hodgins (Domtar Research Centre, Senneville, Quebec, Canada), B. Qvale, J. Koefoed (Danmarks Tekniske Højskole, Lyngby, Denmark), R. K. Swartman (Western Ontario, University, London, Canada), R. Aurille (Electricité de France, Chatou, Yvelines, France), D. N. Glew (Dow Chemical of Canada, Ltd., Sarnia, Ontario, Canada), T. Griebine (Commissariat à l'Energie Atomique, Direction des Productions, Châtillon-sous-Bagneux, Hauts-de-Seine, France), D. M. Gruen (Argonne National Laboratory, Argonne, Ill.), F. C. Hooper (Toronto, University, Toronto, Canada), and J. K. Royle (Sheffield, University, Sheffield, England). In: Thermal energy storage; NATO Science Committee Conference, Turnberry, Scotland, March 1-5, 1976, Report. Brussels, NATO, 1976, p. 27-34. 5 refs.

Low temperature thermal energy storage refers to the storage of heat that enters and leaves the reservoir at temperatures below 120 C. The most important low temperature heat storage schemes - both large scale and small scale systems - are listed and the general economic, engineering and operational problems are identified. Attention is paid to sensible and latent heat storage and to chemical energy storage, and the topics treated are: storage and containment materials, the charging and discharging process, and storage efficiency. B.J.

**A76-45547 # Heat transfer and thermal energy transport.** J. L. Peube (CNRS, Laboratoire d'Etudes Aérodynamique et Thermiques, Poitiers, France), G. F. Hewitt (Atomic Energy Research Establishment, Heat Transport and Fluid Flow Service, Harwell, Oxon, England), E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.), E. Hahne (Stuttgart, Universität, Stuttgart, West Germany), H. W. Hoffman (Oak Ridge National Laboratory, Oak Ridge, Tenn.), P. Le Goff (Ecole National Supérieur des Industries Chimiques, Nancy, France), H. Sandner (München, Technische Universität, Munich, West Germany), D. G. Stephenson (National Research Council, Ottawa, Canada), A. C. Gringarten, and N. Kurti. In: Thermal energy storage; NATO Science Committee Conference, Turnberry, Scotland, March 1-5, 1976, Report. Brussels, NATO, 1976, p. 35-48.

Heat storage in geological strata (geostorage) is considered with attention given to single phase heat transfer in porous media, reservoir stability and heat transfer by conduction in rocks and soils. Also considered are solid and liquid heat storage systems, heat exchanger design, phase change systems for low and high temperature applications (melting and solidification, and encapsulation (of molten salts), fluidized bed storage systems, condensation and boiling, chemical storage systems, and liquid metal storage systems. Energy losses from thermal energy stores, and the transport of energy from the store to the point of use are also examined. B.J.

**A76-45548 # The impact of TES on energy structures.** J. E. Wilson (Ontario Hydro, Energy and Environmental Studies Dept., Toronto, Canada), I. Glendenning (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, England), B. Bourgeois (CNRS, Institut Economique et Juridique de l'Energie, Grenoble, France), I. Fells (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England), D. R. Glenn (GE Valley Forge Space Center, Philadelphia, Pa.), D. Golibersuch (GE Research and Development Center, Schenectady, N.Y.), K. Hannes (STEAG-Anlagentechnik, Essen, West Germany), H. Hörster (Philips Forschungslaboratorium Aachen GmbH, Aachen, West Germany), J. A. Knobbout (Central Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, Apeldoorn, Netherlands), and P. A. Lowe

(ERDA, Thermal Energy Storage Branch, Washington, D.C.). In: Thermal energy storage; NATO Science Committee Conference, Turnberry, Scotland, March 1-5, 1976, Report. Brussels, NATO, 1976, p. 49-72.

Thermal energy storage for residential and commercial energy structures (space heating, water heating, process heat, seasonal storage, etc.) is considered. Some industrial groupings (cement, iron and steel, food, paper, aluminum, batch/variable processes, etc.) considered possible for TES applications are examined. TES is also discussed in relation to urban heating systems (e.g., district heating), energy transport and transportation, and electric utilities. B.J.

**A76-45650 Energy market and energy politics in a European Union (Energemarkt und Energiepolitik in einer Europäischen Union).** H. Michaelis. Frankfurt am Main, Alfred Metzner Verlag GmbH (Planungsstudien, No. 12), 1976. 96 p. 23 refs. In German.

The establishment of common policies for the European countries with regard to energy questions is discussed and the characteristics of the energy economy are considered. Energy supply conditions are examined, taking into account developments before the oil crisis, the procedures of OPEC, and the financial effects of the oil crisis. Attention is given to problems of integration in the energy sector, an optimal integration model for the energy economy, and a realistic model for an integrated energy economy in the European Union. G.R.

**A76-45729 Utilization of the energy in ocean waves.** J. D. Isaacs, D. Castel, and G. L. Wick (California, University, La Jolla; Foundation for Ocean Research, San Diego, Calif.). *Ocean Engineering*, vol. 3, Aug. 1976, p. 175-187. 11 refs. Research supported by the University of California and Foundation for Ocean Research.

The characteristics of ocean wind waves place certain constraints upon devices designed to convert their energy to a useful form. Here we consider the nature of these constraints and the theoretical analysis of a wave power generator that conforms to the design criteria. We also present the results of field tests with several models of the wave power generator. The experimental results support the theory and indicate that such a wave pump is suitable for power generation in a variety of circumstances. (Author)

**A76-45739 Energy consumption, pollutant production, and dollar costs of diesel suburban commuter trains.** E. W. Walbridge (Illinois, University, Chicago, Ill.). *Transportation*, vol. 5, Sept. 1976, p. 285-307. 42 refs. U.S. Department of Transportation Grant No. IL-11-0006.

The results presented in this report are based on data obtained from Chicago's three largest diesel commuter railroads. Those aspects of their operations that relate to energy and pollution are described. Service characteristics, such as average occupancy and average trip distance, are presented. Energy consumption results are presented and discussed. It is found that trips by diesel commuter train are 3.5 times more energy efficient than Chicago Central Area auto trips. The total trip from home to suburban station, then by train to a downtown terminal, is found to be 2.2 times more energy efficient than Chicago Central Area auto trips. Pollutant production rates are presented for five pollutants. For every pollutant except sulfur oxides, trains are found to be less polluting per passenger-mile than autos. Travel on these diesel commuter trains is less costly to society than auto travel. This is the case whether one compares the train trip alone with an auto trip or the home-to-suburban-station-then-to-a-downtown-terminal trip with a home-to-downtown auto trip. (Author)

**A76-45843 Coal research. IV - Direct combustion lags its potential.** A. L. Hammond. *Science*, vol. 194, Oct. 8, 1976, p. 172, 173, 218, 220.

The paper examines the state of development of two of the

most promising means of direct coal burning for energy that achieve significant removal of sulfur dioxide: the conventional boiler with gas scrubber equipment, and the fluidized bed. The basic concepts and processes of these two techniques are described, and some of the most important problems facing their realization are discussed. One of the most difficult problems associated with lime and limestone scrubbers is sludge disposal. This problem is the incentive for developing regenerable scrubbing processes. Fluidized bed technology is now being tested in a prototype boiler plant in Rivesville, West Virginia. Although this process consumes as much limestone as a scrubber, the waste material is more easily disposed of than sludge. Although both gas scrubbers and fluidized beds will be needed in the 1980s and beyond, they will face problems of evolving environmental standards and new information about atmospheric chemistry, which might obviate their need or considerably modify their application. P.T.H.

**A76-45851**      **Solar energy economics - The a priori decision.** J. A. Clark (Michigan University, Ann Arbor, Mich.). *International Journal of Heat and Mass Transfer*, vol. 19, Oct. 1976, p. 1095-1106. 9 refs.

The initial decision concerning the economic viability of a solar energy heating system is shown to involve technical, physical, meteorological, geographic, design and cost factors as well as the source of funding and type of arrangements made to finance the system. Four economic/technical models, which include the influence of increasing fuel costs, are presented and compared with other possible kinds of investments to determine the economic viability of the system. It is found that different economic conclusions are both possible and justifiable for investment situations, having different constraints. (Author)

**A76-45875**      **The storage of low grade thermal energy using phase change materials.** K. K. Pillai and B. J. Brinkworth (University College, Cardiff, Wales). *Applied Energy*, vol. 2, July 1976, p. 205-216. 9 refs.

Phase change materials (PCMs) offer a convenient means of storing low grade thermal energy within compact systems, however, the selection of the proper PCM depends entirely on the particular application. The difficulties in predicting the melting behavior of PCMs have limited the production of working designs. The generalized properties of three categories of PCM - paraffins, non-paraffin organic solids, and hydrated salts - are described. A number of phase change materials are given in an appendix, along with their transition temperature, heat of transition, and type of transition. A data bank suitable for selecting materials with desired combinations of properties is currently being set up. V.P.

**A76-45993** #      **Application of solar panels to domestic heating and hot water supply (Application des panneaux capteurs de l'énergie solaire au chauffage et à l'eau chaude à usage domestique).** A. Trimboli (PanelSol P.S.A., Madrid, Spain). In: International Scientific-Technological Conference on Space, 16th, Rome, Italy, March 18-20, 1976, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1976, p. 521-524. In French.

The design and operation of the PANELSOL system, a high-efficiency solar collector, which will maintain the circulating fluid at temperatures as high as 80 C are discussed. Built of materials characterized by high absorption of the entire solar spectrum, the collector uses a honeycomb system to diminish the emission of the panels and to concentrate the solar emission. The characteristics of the system circuits are examined. V.P.

**A76-45994** #      **Thermal atmospheric power system concepts (Konzepte Atmosphärenthermische Kraftwerks-Systeme).** D. I. M. Simon. In: International Scientific-Technological Conference on Space, 16th, Rome, Italy, March 18-20, 1976, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1976, p. 525-536. In German.

Thermal atmospheric area power systems exploiting insolation of a roofed-over area, with the ground acting as a natural collector of sunshine energy, and a central chimney providing a convection channel for extracting energy from air currents generated, are described. Transformation of the kinetic energy of the rising air currents traversing the vertical chimney into electric power or mechanical shaft output by means of wind turbines, and utilization of random horizontal wind in addition by means of an auxiliary slewable wind turbine stage atop the vertical chimney, are also described. The concepts are recommended primary for energy-poor semi-arid regions with abundant insolation. Applications in more temperate environments are also considered. R.D.V.

**A76-45995** #      **A solar power plant in the 10 KWe range with focusing collectors.** W. Kleinkauf, R. Köhne, F. Lindner (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany), and M. Simon (Maschinenfabrik Augsburg-Nürnberg, AG, Neue Technologie, Munich, West Germany). In: International Scientific-Technological Conference on Space, 16th, Rome, Italy, March 18-20, 1976, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1976, p. 541-550.

A 10-kWe solar power plant with focusing collectors (parabolic troughs) is described. The advantages and disadvantages of two different mountings, a simple and a more sophisticated tracking device, are discussed. The collector itself and the thermal cycle with a steam engine, storage, and an additional boiler are treated. Finally, the installation and electricity costs are presented as a function of hours of sunshine per year for the 10-kWe plant as well as larger plants. (Author)

**A76-45996** #      **Solar cell fueled power plant for a low-power radio relay link (Impianto di alimentazione a celle solari per un ripetitore di ponte radio di piccola potenza).** P. L. Finocchi (Compagnia Industriale Aerospaziale S.p.A., Rome, Italy). In: International Scientific-Technological Conference on Space, 16th, Rome, Italy, March 18-20, 1976, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1976, p. 551-560. In Italian.

Power sources for low-power stationary or mobile electric power plants are reviewed and compared. Auxiliary power sources for an electric power line, SNAP type nuclear isotope generators, thermionic diodes (Cs vapor) and direct converters, solar energy direct converters, fuel cells, and conventional chemical batteries are evaluated and compared as possible sources for small low-power electric power generating plants serving radio relay links, weather monitoring stations, radio beacons, light buoys, and remote locations. Building a direct solar energy conversion plant near the power plant, with a system of lead batteries to handle nighttime load or load in periods of low sunlight, is viewed as most cost-effective. R.D.V.

**A76-45997** #      **Economic-energetic analysis in the field of unconventional thermal energy - The possibilities and limitations of geothermal and solar energy (Indagine economico energetica nel campo dell'energia termica non convenzionale - Possibilità e limite dell'energia geotermica e dell'energia solare).** G. de Comelli (Trieste, Università, Trieste, Italy). In: International Scientific-Technological Conference on Space, 16th, Rome, Italy, March 18-20, 1976, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1976, p. 561-572. 24 refs. In Italian.

The main purpose of this paper is to survey the present state of the practical employment of geothermal and solar energy. Geothermal and solar energy are examined in order to point out the natural limits of their practical availability and the technological obstacles to their employment. The most important results obtained in the utilization of the two sources of energy considered are summarized. (Author)

**A76-46023** U.S. energy supply and reserve estimation of geothermal steam projects. C. H. Keplinger (Keplinger and Associates, Inc., Tulsa, Okla. and Houston, Tex.). *Geothermal Energy*, vol. 4, Sept. 1976, p. 7-11.

Factors which make it attractive to consider geothermal development are related to the decline in oil production and reserves, the declining gas production, the total energy outlook through at least 1990, the price of the substitute for geothermal energy, and the existence of geothermal areas in the western part of the U.S. An assessment of the geothermal resources of the U.S. conducted by the U.S. Geological Survey is considered. The total geothermal resource of all classifications, identified and undiscovered resources, was 153,400 megawatts. An economic analysis of the development of the Geysers thermal field in California is discussed. G.R.

**A76-46024** Legal issues in the development of geopressed geothermal resources of Texas and Louisiana Gulf Coast. D. B. Elmer. *Geothermal Energy*, vol. 4, Sept. 1976, p. 13-19, 22-25, 27, 28 (9 ff.).

Cases concerning geothermal resources are considered. Resource definition is followed by an analysis of the ownership complex. Questions of taxation on both state and federal levels are examined. Attention is given to the interrelationships between physical and legal models of geothermal resources. The statutory legal models are largely based on the provisions of the Geothermal Steam Act of 1970 or the Geothermal Resources Act of 1967. State laws and regulations concerning geothermal resources are also considered. G.R.

**A76-46025** Geothermal activity in Iceland. H. W. Falk, Jr. (Magma Power Co.). *Geothermal Energy*, vol. 4, Sept. 1976, p. 44-46.

A description is presented of a project involving the construction of a 60,000 kilowatt geothermal power plant at Krafla. Two geothermal wells have been drilled near the City of Akureyri with the objective to construct for this city a hot water system similar to that in Reykjavik. The hot water in Reykjavik is produced from about 75 wells having temperatures in the range from 185 to 285 F. Attention is also given to the development of an area with extensive geothermal activity in the vicinity of Nesjavellir. G.R.

**A76-46059 \* #** Space and energy. I. Bekey (Aerospace Corp., El Segundo, Calif.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-121*. 13 p. 11 refs. Contract No. NASw-2727.

Potential contributions of space to energy-related activities are discussed. Advanced concepts presented include worldwide energy distribution to substation-sized users using low-altitude space reflectors; powering large numbers of large aircraft worldwide using laser beams reflected from space mirror complexes; providing night illumination via sunlight-reflecting space mirrors; fine-scale power programming and monitoring in transmission networks by monitoring millions of network points from space; prevention of undetected hijacking of nuclear reactor fuels by space tracking of signals from tagging transmitters on all such materials; and disposal of nuclear power plant radioactive wastes in space. (Author)

**A76-46094 #** Modular solar energy systems for future space laboratories. J. Rath and E. F. Schmidt (Telefunken AG, Hamburg, West Germany). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-252*. 10 p. 9 refs. Research supported by the Bundesministerium für Forschung und Technologie.

The paper discusses three basic large lightweight solar array concepts for future space laboratories: semi-flexible foldable arrays, flexible fold-out arrays and flexible roll-out arrays. The flexible roll-out array DORA, designed for a 9 kW mission, is described in detail. This array is designed as a modularly integrated unit which may be applied to the power requirements of Spacelab. B.J.

**A76-46116 #** Solar and other related energies and their impact upon space law. A. A. Cocca (Ministry of Foreign Affairs, Buenos Aires, Argentina). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper ISL-76-19*. 6 p. 10 refs.

Certain proposals are presented concerning the legal aspects of solar and related energies. They include the banning of all national appropriation of energy coming from space, the declaration of the geostationary orbit as a limited natural resource and a common heritage of mankind, an equality regime for states inside and outside the 'solar belt', and the banning of the utilization of solar and related energies except for peaceful purposes. Solar energy is discussed in relation to the role of the United Nations. B.J.

**A76-46117 #** Space energy law and the hierarchy of norms. E. Fasan. *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper ISL-76-20*. 5 p. 10 refs.

The idea that legal norms show a tendency to sometimes form a kind of 'hierarchy' has been systematized by Kelsen and by Mehl into the framework of the pure theory of law. Beginning with the formulation of basic legal notions of Space Law in UN Resolutions, the Space Treaty of 1967 brought a kind of constitution for Space and Celestial Bodies. The liability Convention the Rescue Agreement, and the Registration Convention brought about more specialized regulations. It is seen that the Space Energy Law will have its place in this hierarchy of norms. V.P.

**A76-46118 #** Space law and energy relationship with the outer space - A question of international heritage of mankind. C. C. Okolie (Lewis University, Glen Ellyn, Ill.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper ISL-76-21*. 11 p. 61 refs.

The basic issues of jurisdiction in personam and jurisdiction in rem are studied as they pertain to the establishment of law and order in space. Contemporary proposals, disagreements, and political uses are discussed. It is concluded that multilateral treaties are hard to enforce, while bilateral treaties on mutually agreeable principles are more readily accepted, and are regarded as more important, than multilateral treaties. All nations on earth should contribute to and have an investment interest in the exploration of space and be entitled by law to the benefits derived in proportion to their investment. This would aid to resolve the basic conflict on space and possible natural resources on the moon or other celestial bodies. Common heritage, as a new concept of international law, can be justified only by a joint commitment and effort of all nations to share the burden of space research and expenditure. V.P.

**A76-46150 #** An exposition of advanced large area spacecraft solar array technology. L. G. Chidester (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-250*. 9 p. 11 refs.

Silicon solar arrays have provided the energy source for virtually all space satellites with orbital lifetimes greater than 30 days. The first experimental solar panels were orbited in 1958 and as early as 1961 large area solar arrays providing up to 1 kilowatt were qualified and used on classified programs. This paper will review the large area solar array development progress at Lockheed including the 100 kilowatt space station solar array and provide an up to date progress report on the newest United States large area lightweight solar array which is being developed for the NASA Solar Electric Propulsion (SEP) Spacecraft. The 25 kilowatt SEP solar array is approximately 4 meters wide and 65 meters long. (Author)

**A76-46195** Solid-dielectric compound parabolic concentrators - On their use with photovoltaic devices. N. B. Goodman, L. Wharton, R. Winston (Chicago, University, Chicago, Ill.), and R. Ignatius (M7 International, Arlington Heights, Ill.). *Applied Optics*, vol. 15, Oct. 1976, p. 2434-2436.

Prototype solid dielectric compound parabolic concentrators have been made and tested. By means of the geometry and refractive properties of a transparent solid they provide a technique for increasing the power output of silicon solar cells exposed to the sun by an amount nearly equal to the increase in effective collecting area. The response is uniform over a large angle which eliminates the necessity of diurnal tracking of the sun. The technique can be applied to the construction of thin panels and has the potential for significantly reducing their cost per unit area. (Author)

**A76-46259** The photovoltaic generation of electricity. B. Chalmers (Harvard University, Cambridge, Mass.). *Scientific American*, vol. 235, Oct. 1976, p. 34-43.

Since the principles underlying all photovoltaic devices are the same, the paper describes their construction and operation in terms of the silicon solar cell for photovoltaic generation of electricity. The behavior of electrons in a silicon crystal is outlined. The silicon solar cell is referred to as a wafer of p-type silicon with a thin layer of n-type silicon on one side. Particular attention is given to technological processes for growing silicon crystals and to the cost effectiveness of photovoltaic cells. Solar energy will become more attractive as the price of energy-producing fuels increases and as environmental restrictions further raise the cost of generating electricity with them. S.D.

**A76-46322** Physical aspects of windmill design. P. T. Smulders (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). *Physics in Technology*, vol. 7, Sept. 1976, p. 208-214.

General considerations on the role of and the prospects for wind energy utilization are followed by a discussion of the basic performance characteristics of a windmill and their relationships to some of its technical characteristics. In considering aerodynamic aspects of wind energy utilization, turbines using drag as the propelling force are compared with Betz's ideal axial-flow wind turbine model. A classification of windmill types is given, in terms of their propelling force (lift or drag), with special attention to the panemone type and the horizontal-axis propeller type turbines. Current methods of calculating performance characteristics and recent progress in obtaining high performances by developing new configurations of windmills are examined. Attention is given to the problems of steady and nonsteady dynamic loading of a wind machine related to the wind structure. S.N.

**A76-46477 \*** Hydrogen as an energy medium. K. E. Cox (New Mexico, University, Albuquerque, N. Mex.). In: Effect of hydrogen on behavior of materials; Proceedings of the International Conference, Moran, Wyo., September 7-11, 1975.

New York, Metallurgical Society of AIME, 1976, p. 3-16; Discussion, p. 17. 24 refs. Research supported by the Westinghouse Electric Corp., EPRI, and NASA.

Coal, though abundant in certain geographical locations of the USA poses environmental problems associated with its mining and combustion. Also, nuclear fission energy appears to have problems regarding safety and radioactive waste disposal that are as yet unresolved. The paper discusses hydrogen use and market projection along with energy sources for hydrogen production. Particular attention is given to hydrogen production technology as related to electrolysis and thermochemical water decomposition. Economics of hydrogen will ultimately be determined by the price and availability of future energy carriers such as electricity and synthetic natural gas. Thermochemical methods of hydrogen production appear to offer promise largely in the efficiency of energy conversion and in capital costs over electrolytic methods. S.D.

**A76-46478** Hydrogen's potential as a vehicular fuel for transportation. R. E. Billings (Billings Energy Research Corp., Provo, Utah). In: Effect of hydrogen on behavior of materials; Proceedings of the International Conference, Moran, Wyo., September 7-11, 1975.

New York, Metallurgical Society of AIME, 1976, p. 18-33. 18 refs.

Earlier studies on the use of hydrogen as a vehicular fuel for transportation have revealed that liquid hydrogen generated from coal competes very poorly with other vehicular transportation alternatives. Recent developments with metal hydride storage techniques and with increased engine operational efficiencies are reviewed. It is shown that observation of improved engine operating efficiencies, development of successful methods for virtual elimination of nitric oxide formation, and creation and refinement of metal hydride storage systems have all enhanced hydrogen's potential as an alternate fuel for vehicular transportation. A thermodynamic cycle analysis in terms of efficiency, maximum power loss, and emissions is also included. S.D.

**A76-46510** Hydrogen compatibility of structural materials for energy-related applications. J. H. Swisher (Sandia Laboratories, Livermore, Calif.). In: Effect of hydrogen on behavior of materials; Proceedings of the International Conference, Moran, Wyo., September 7-11, 1975.

New York, Metallurgical Society of AIME, 1976, p. 558-575; Discussion, p. 576, 577. 15 refs.

The need for hydrogen compatibility work in support of energy storage and transmission technology is assessed with particular reference to pressure vessels for hydrogen and pipelines for high pressure hydrogen. Problems of designing and constructing pressure vessels and pipelines for high-pressure hydrogen are particularly difficult in view of the size of the facilities, the difficulty of quality control, and the requirement to use low-cost materials. In underground pipelines, the problem is compounded by possible corrosive attack leading to crack formation. For hydrogen storage vessels, the hydrogen pressures are seen to be sufficiently low to permit the use of ordinary steels, as long as the design is conservative or special design features are incorporated. In all applications, there appears to be no critical need for new alloy development to protect against hydrogen damage. However, development of low cost alloys or alloys with better properties should not be discouraged. V.P.

**A76-46524** Energy outlook and combustion research (Conjoncture énergétique et recherches en combustion). J.-C. Balaceanu (Institut Français du Pétrole, des Carburants et Lubrifiants, Rueil-Malmaison, Hauts-de-Seine, France). (*Symposium Européen sur la Combustion, 2nd, Orléans, France, Sept. 1975.*) Institut Français du Pétrole, *Revue*, vol. 31, Mar.-Apr. 1976, p. 347-357. In French.

The paper examines some facts concerning the world's fossil fuel reserves and attempts to draw some conclusions regarding trends in future exploitation of fossil fuel energy sources. Attention is called to various areas of combustion for which continued research is necessary for increasing economic benefits and reducing the amount of pollution created by fossil fuel combustion. P.T.H.

**A76-46800** Energy research - Accelerator builders eager to aid fusion work. J. H. Nuckolls (California, University, Livermore, Calif.). *Science*, vol. 194, Oct. 15, 1976, p. 307-309.

A scheme for producing useful thermonuclear power with the aid of an intense beam of heavy ions is considered. By splitting the beam into a number of components, the ions would be made to strike a small fuel pellet from a number of directions and, thereby, ignite a thermonuclear explosion. The energy of the reaction products could be converted to heat for the generation of electric power in a turbogenerator. Approaches and existing technology for the implementation of the scheme are considered, taking into account the requirements concerning the design of a driver for inertial fusion. G.R.

**A76-47018** Scientific and engineering problems of development of energy industry in the USSR. M. A. Styrikovich (Academy of Sciences, Dept. of Physical and Engineering Problems of Energy, Moscow, USSR). (*Akademiia Nauk SSSR, Izvestia, Energetika i Transport*, May-June 1974, p. 3-11.) *Heat Transfer - Soviet Research*, vol. 7, Sept.-Oct. 1975, p. 40-49. Translation.

The energy crisis is discussed and the development of new energy technology in the Soviet Union is considered. Emphasis is on nuclear power generation (breeder reactors), coal and natural gas utilization, and MHD power generation. B.J.

**A76-47051 International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976; Proceedings.** Symposium sponsored by the Electrochemical Society. Edited by J. B. Berkowitz (Arthur D. Little, Inc., Cambridge, Mass.) and I. A. Lesk (Motorola, Inc., Phoenix, Ariz.). Princeton, N.J., Electrochemical Society, Inc., 1976, 369 p. \$10.00.

The papers collected deal principally with advances in technology and materials for conversion of solar energy into electrical energy with the aid of solar cells, with some work relating to technology for photothermal conversion and photogalvanic and photochemical cells. Some of the topics covered include chemical vapor deposition of molybdenum and tungsten films of high infrared reflectance, analysis of current-voltage and power characteristics of photogalvanic cells, thin film GaAlAs-GaAs solar cells by peeled film technology, a comparison of GaAs and Si hybrid solar power systems, purification of metallurgical-grade silicon to solar grade, use of solar cells in a compound parabolic collector, and accelerated life performance characteristics of thin film Cu<sub>2</sub>S-CdS solar cells.

P.T.H.

**A76-47052 Solar energy applications - 1976.** J. I. Yellott. In: International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976, Proceedings. Princeton, N.J., Electrochemical Society, Inc., 1976, p. 1-15. 10 refs.

The three basic domains of heliotechnology are characterized, namely, heliochemical, heliothermal, and helioelectrical processes, and some of the more successful concepts that have been realized or are under development for converting the sun's radiant energy to useful heat for space and water heating (and cooling), are briefly described. The economic desirability of solar water heating as opposed to conventional water heating is explained. The concepts of passive and active systems for space heating are examined, and active systems using air or based on rock-pile storage are described. The two currently explored concepts for developing heliothermal cycles for generation of large quantities of power are outlined, namely, the use of long arrays of parabolic troughs that reflect solar rays to absorbers, and the use of a steam generator mounted atop a tall tower and receiving radiant energy from thousands of heliostats around it. P.T.H.

**A76-47053 Thermal storage for solar energy conversion.** R. T. LeFrois (Honeywell Systems and Research Center, Minneapolis, Minn.) and H. V. Venkatesetty (Honeywell Corporate Research Center, Bloomington, Minn.). In: International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976, Proceedings.

Princeton, N.J., Electrochemical Society, Inc., 1976, p. 16-35. Contract No. E9(04-3)-1109.

The paper describes the thermal storage subsystem for storing thermal energy by melting eutectic salts, that forms part of a central-receiver type solar thermal power pilot plant. The thermal storage unit is divided into individual cells for improved phase change performance. Each cell contains one charge cycle heat exchanger and one discharge cycle heat exchanger. Twelve main storage unit cells will generate saturated steam while another set of cells will generate superheated steam. The salt selected for the main storage is a ternary eutectic mixture of NaCl, NaNO<sub>3</sub>, and Na<sub>2</sub>SO<sub>4</sub> with eutectic temperature of 287 C and heat of fusion of 94.2 kWh(t)/cu m. P.T.H.

**A76-47055 Photogalvanic cells. II - Current-voltage and power characteristics.** W. J. Albery (Oxford University, Oxford, England) and M. D. Archer (Royal Institution, London, England). In: International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976, Proceedings. Princeton, N.J., Electrochemical Society, Inc., 1976, p. 50-65.

The work analyzes the current-voltage and power characteristics of a common type of photogalvanic cell containing two identical electrodes, one immersed in illuminated solution, the other in dark solution, whereby it is assumed all diffusion coefficients are equal. The analysis is in terms of the electrode kinetics of the redox couples, the concentration of the redox species, and the position of the photostationary state. It is further assumed that the overall cell length is significantly greater than the sum of the diffusion layers at the two electrodes, so that cell performance is independent of cell length. The optimal case is when one redox couple is reversible and the other is irreversible, and this case is examined in more detail.

P.T.H.

**A76-47056\* Photoelectrochemical cells - Conversion of intense optical energy.** M. S. Wrighton, A. B. Ellis, and S. W. Kaiser (MIT, Cambridge, Mass.). In: International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976, Proceedings.

Princeton, N.J., Electrochemical Society, Inc., 1976, p. 66-91. 47 refs. NASA-supported research.

Conversion of optical energy to chemical energy and/or electrical energy using wet photoelectrochemical cells is described. Emphasis is on (1) the photoelectrolysis of H<sub>2</sub>O to H<sub>2</sub> and O<sub>2</sub> using cells having n-type semiconductor photoelectrodes fabricated from TiO<sub>2</sub>, SnO<sub>2</sub>, SrTiO<sub>3</sub>, KTaO<sub>3</sub>, and KTa(0.77)Nb(0.23)O<sub>3</sub>, and (2) the conversion of light to electrical energy using CdSe- and CdS-based cells with polysulfide electrolytes. (Author)

**A76-47057 Sensitization of TiO<sub>2</sub> for photoelectrolysis of water.** A. K. Ghosh and H. P. Maruska (Exxon Research and Engineering Co., Linden, N.J.). In: International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976, Proceedings. Princeton, N.J., Electrochemical Society, Inc., 1976, p. 92-100. 15 refs.

The photoelectrolysis of water using semiconducting TiO<sub>2</sub> has been demonstrated by many workers. Unfortunately, TiO<sub>2</sub> absorbs only a small fraction of the sunlight since optical absorption in TiO<sub>2</sub> commences at 415 nm and extends into the ultraviolet. The present work reports efforts to extend the response of TiO<sub>2</sub> to visible light by impurity doping, dye sensitization and heterojunction formation. Some theoretical analysis of carrier generation and transport due to light absorbed in the barrier and bulk region is presented. (Author)

**A76-47058 Aging effects in single crystal reduced rutile anodes.** L. A. Harris and R. H. Wilson (General Electric Co., Schenectady, N.Y.). In: International Symposium on Solar Energy, Washington, D.C., May 5-7, 1976, Proceedings. Princeton, N.J., Electrochemical Society, Inc., 1976, p. 101-127. 22 refs.

Single crystal samples of reduced rutile used as anodes in a photoelectrochemical cell with 1.0N H<sub>2</sub>SO<sub>4</sub> show significant changes with use. Saturated photocurrent as a function of illumination wavelength and differential capacitance as a function of anode half-cell voltage were measured before and after varying periods of operation under intense illumination. Shifts in the photoresponse and capacitance are observed only when the illuminating photon energy exceeds the band-gap energy of rutile and when a field exists in the crystal. The changes, possibly indicating a motion of donors toward the crystal surface, are also accompanied by an eventual loss in quantum efficiency and striking alterations in surface morphology. (Author)

**A76-47207 A solar thermal electric power overview.** R. P. Stromberg (Sandia Laboratories, Albuquerque, N. Mex.). In: Engineering in a changing economy; Proceedings of the Southeast Region 3 Conference, Clemson, S.C., April 5-7, 1976. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 74, 75.

An aggressive program to establish the feasibility of solar energy for producing electricity is being sponsored by the Energy Research and Development Administration (ERDA). Two major ideas are being pursued. Central power plants, remotely located, would replace conventionally fueled plants. Total energy systems, closer to the developed areas of cities, would produce electricity and utilize the large amounts of thermal energy otherwise lost. Economies of solar energy systems look marginal in contrast to current fuel prices. It will be necessary to change incentives in order to accelerate the transfer from fossil fuels to alternate sources of energy. (Author)

**A76-47208** Solar energy options for electric utilities. H. I. Leon, R. Gorman, and R. Dawley (TRW Systems, McLean, Va.). In: Engineering in a changing economy; Proceedings of the Southeast Region 3 Conference, Clemson, S.C., April 5-7, 1976. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 76-78.

Four solar electric technologies for utilities are examined: solar thermal, solar photovoltaic, ocean thermal, and wind conversion. The technologies are assessed and compared by defining a baseline of conventional plants, the solar electric plant objectives for performance, capital cost and year of commercial availability, and a standard set of economic measures to calculate bus bar cost. B.J.

**A76-47225** The impact of solar heating and cooling of homes on the electric utility. R. Aseltine (Tennessee, University, Knoxville, Tenn.). In: Engineering in a changing economy; Proceedings of the Southeast Region 3 Conference, Clemson, S.C., April 5-7, 1976. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 174-176. 9 refs.

An intuitive analysis of the possible impact of solar heating and cooling of homes on the electric utility is made. Consideration is given to the load imposed by electrical backup units, and how this relates to the need for additional generation and transmission facilities. A reduction in the short term weather sensitive load through the normal operation of solar units is shown to yield a savings in daily generation costs, however, careful coordination of the various systems must be implemented for maximum efficiency. (Author)

**A76-47275 #** Direct thermal to electrical energy conversion with the prototype of thermionic converter developed at the Institute of Physics, Bucharest. I. Performances of series and parallel connected group of converters. G. Musa, A. Popescu, A. Baltog, I. Mustata, N. Niculescu, and A. Cormos (Academia Romana, Institutul de Fizica, Bucharest, Romania). *Revue Roumaine des Sciences Techniques, Série Electrotechnique et Energétique*, vol. 21, July-Sept. 1976, p. 471-476. 34 refs.

**A76-47282** Sensible energy utilization through use of heat pumps (Sinnvolle Energieanwendung unter Einsatz der Wärmepumpe). H. Kirn. *Energiewirtschaftliche Tagesfragen*, vol. 26, Sept. 1976, p. 500, 502, 504-507. In German.

The paper describes the basic concept behind heat pumps, which draw relatively low-temperature heat from the environment, and raise its temperature, at the cost of electrical energy input, through an evaporation-compression-condensation process, so that it can be efficiently distributed to the space being heated. Three possible sources of external heat are considered: the ambient air, underground water, and the ground itself. Warm-water floor heating is the most suitable distribution method. The ratio of useful heat to consumed input work lies between 2.6 and 3.5, depending on type of system. P.T.H.

**A76-47285** Wind energy. B. Sorensen (Copenhagen, University, Copenhagen, Denmark). *Bulletin of the Atomic Scientists*, vol. 32, Sept. 1976, p. 38-45. 20 refs.

General resources of wind energy are evaluated, and its main applications are considered, such as conversion into electricity and

heat, hydrogen production, and irrigation, along with the associated problem of long-term energy storage. The basic principles of windmill system design and favorable location selection are outlined. The environmental impact of the windmill systems is discussed. It is noted that wind energy can be converted into electricity with minimal energy losses, as compared with most other systems, involving the heat-electricity conversion step. The most promising method of wind energy long-term storage is found to be the use of hydrogen (for heating, propulsion and, in the not-so-distant future, the regeneration of electricity by means of fuel cells). Comparison is made of electric power generation economic efficiency by different methods, especially from wind and nuclear sources, and it is concluded that since the estimated cost of wind energy is sufficiently close to that of energy from alternative sources, other factors are decisive in the choice, such as uncertainty of fuel costs and supply, the adverse environmental impact of fuel-based energy production, and importance of restraining the use of non-renewable resources in the interest of future generations. However, until economically efficient storage systems are developed, wind energy can be used only as a supplement to the conventional energy supply. S.N.

**A76-47286** Energy economics. L. M. Liberman (Laclede Gas Co., Mo.). (American Gas Association, Marketing Conference, Boston, Mass., Mar. 16, 1976.) *American Gas Association Monthly*, vol. 58, June 1976, p. 4-7, 32.

The paper examines the history, major facts and causes of the current energy crisis in the United States. The U.S. dependence on foreign oil is evaluated as a question of national economical survival. Natural gas and its inadequate development due to governmental regulation is considered to lie at the heart of the problem. U.S. fossil fuel resources are assumed to ensure the long-run future energy supply, the problem being in creating an adequate national program encouraging the discovery and development of these resources. The major points of such a program are tentatively proposed, including restraining demand in the short term, more efficient use of natural gas by supplanting it with coal, and finding nonpollutional methods for the utilization of coal to generate electricity. Particular attention is given to coal gasification. It is asserted that adoption of the alternative 'all-electric concept' could only aggravate the crisis. S.N.

**A76-47287** Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. Symposium sponsored by American Institute of Aeronautics and Astronautics. Edited by F. J. Hendel (California Polytechnic State University, San Luis Obispo, Calif.). North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc. (Monograph on Alternate Fuel Resources. Volume 20), 1976. 469 p. \$45.

The present collection of papers is concerned with advances in and projects for alternatives to conventional fuels and energy sources in order to meet the USA future energy requirements. Major areas discussed include overall aspects of alternate fuel resources, development of synthetic fuels, gas turbine and diesel oil alternates, oil shale retorting, and alternates to gasoline in automotive transportation. Other topics concern gas and coal utilization, pollution consideration in alternate fuels, and fuel and energy from solid waste and biomass. S.D.

**A76-47288 #** Changing energy perspectives. G. C. Werth (California, University, Livermore, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 3-14. 7 refs. Contract No. W-7405-eng-48.

Several new developments call for a reassessment of the U.S. energy independence strategy: (1) conservation programs have not been effectively implemented; (2) industry is not building synthetic-fuel production plants; and (3) a projected world-wide expansion of



oil production may actually lead to price reductions in the 1980's followed by price increases in the 1990's. We use the Stanford Research Institute energy market model to evaluate these new developments. It indicates that acceleration of research and development on synthetic fuels and on increasing the efficiency of energy use may lead to reductions of over \$100 billion in the total annual U.S. energy bill in the year 2000 and to a reduction of \$30 billion in the total annual energy import bill. Since transportation is the most inefficient sector in terms of energy use, and more and more Americans seem to prefer suburban living, increasing the efficiency of the automobile is crucial. (Author)

**A76-47289 # An overview of alternate energy resources for power generation - 1975-2000.** L. G. Hauser (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 15-22, 9 refs.

The paper discusses the probable future trends in electric power generation in terms of energy source and type of generation for the period 1975-2000 in the USA. Twelve new energy system alternatives are shown to be suitable for successful economic feasibility. Selections should be made among these 12 alternatives for higher priority development efforts. Five alternatives would be most beneficial for the last quarter of this century: breeder reactor with steam turbines, combined cycle (combustion/steam turbine) with a coal-derived fuel, steam turbine fired by municipal wastes, wind turbine generators, and batteries. S.D.

**A76-47291 # Natural crude oil as an alternate fuel.** F. S. Crane (California Polytechnic State University, San Luis Obispo, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 40-48, 5 refs.

Natural crude oil is presently the principal energy source in the USA but is considered an alternate fuel under certain conditions. The oil is excluded from the category of primary fuel due to lack of availability. Both the residue left in producing fields and the undiscovered deposits are classed as alternate fuels. The development of such resources is discussed and justified, with special emphasis on secondary and tertiary recovery techniques. 68% of all previously discovered oil is regarded as residue under present price and technology. However, the technology is available to recover 50% of the present residue, at the price of upper tier oil. S.D.

**A76-47292 # Composite residential power supply systems - A projection.** W. B. Patterson (USAF, Space and Missile Test Center, Vandenberg AFB, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 49-57, 20 refs.

The paper presents a brief survey of alternate energy sources, with special emphasis on small-scale solar energy sources. Energy sources are discussed relative to capital sources (petroleum, coal, etc.), controlled fusion processes, renewable sources (hydroelectric, geothermal, tidal, etc.), and solar energy (photocells, focused collectors, and flat-plate collectors). Heating and cooling applications of solar energy are indicated. The main reason for the decline of solar water heaters is reported to be a strong promotion campaign to have everyone switch to utility-powered water heaters. The main areas of action should be to educate the public concerning solar energy and to take steps to make its use economical. S.D.

**A76-47293 # Solar heating system for airport pavement snow, slush, and ice control.** E. Bromley, Jr., H. D'Aulerio (FAA, Washington, D.C.), and M. Pravda (Dynatherm Corp., Los Angeles, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North

Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 58-69, 6 refs.

The technical and economic practicability of a solar energy pavement heating system for use in snow, slush and ice control on airport runways, taxiways and ramps is discussed. The preliminary design considers the winter climate, the air traffic density and the operating and total system costs. Cost comparison between a solar, electrical and a steam fired system are given together with a 'SNOP' number which is unique to each airport. Through use of the 'SNOP' number, each airport management can predict when the practicality of a solar system should be considered. (Author)

**A76-47294 # COSTEAM - The newest coal liquefaction process.** H. R. Appell (ERDA Energy Research Center, Pittsburgh, Pa.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 74-79, 11 refs.

COSTEAM is a low-cost process for converting lignite and some bituminous coals to a low-sulfur low-ash industrial fuel oil using synthetic gas (carbon monoxide plus hydrogen) and water in place of hydrogen. The mineral components naturally present in the coals provide enough catalytic activity so that added catalysts are not necessary. Conversion of coal to fuel oil plus water and gas averages near 90 per cent at temperatures of 425 to 450 C and pressures of 3,000 to 4,000 psig. In the case of lignite, conversion with synthetic gas is actually higher than with hydrogen under the same conditions in the absence of added catalysts. In the case of bituminous coals, the use of synthetic gas does not result in higher yields as compared with hydrogen, but in lower processing costs. (Author)

**A76-47295 # LLL in-situ coal gasification program.** D. R. Stephens (California, University, Livermore, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 80-104, 26 refs.

Potential advantages of in-situ (underground) coal gasification are that the product may be cheaper because of lower capital investment, environmental damage is likely to be lower, and it may be possible to exploit coal resources found at depths too great to be economically attractive for conventional strip- or deep-mining operations. Results are presented for a successful deep exploratory drilling program to delineate and characterize potential coal sites in specified areas of the USA. Design of cost-effective gasification process is discussed. Coal gasified in 1-ft-long packed-bed reactors with steam and oxygen yields gas qualities almost equal to those obtained by the Lurgi process. Modeling studies are initiated to consider convective instabilities, coal plasticity, and the effect of spatial distribution of collection and production pipes on resource recovery. A description is given of the planned Hoe Creek gasification experiment devised on the basis of laboratory experimental and modeling data. S.D.

**A76-47296 # The cost and possible timing of synthetic liquid fuels from coal.** T. A. R. Guldman (Chevron Research Co., Richmond, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings.

North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 110-115.

The paper assesses the applicability of available processes of obtaining synthetic liquid fuels from coal, along with their investment and operating costs. The available processes are classified as pyrolysis, indirect liquefaction via gasification, and direct liquefaction. Pyrolysis is not discussed because of the relatively low yield of liquid relative to the char production. Emphasis is placed on the capabilities of the donor solvent process, the solvent refined coal process, and the H-coal process. No commercial light products from

coal are expected before 1987 and probably no more than 100,000 BPCD by 1990. Acute difficulties in funding the development of new coal liquefaction technology are predicted. S.D.

**A76-47297 # Diesel fuels from shale oil.** P. L. Cottingham (ERDA Energy Research Center, Laramie, Wyo.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 119-135. 17 refs.

The paper reviews some of the investigations for producing diesel fuels from shale oil. Raw diesel fuel fractions can be prepared from crude shale oil by simple distillation, by thermal cracking, or by coking of the crude oil followed by distillation of a light gas oil of the appropriate boiling range. Diesel fuels of good quality have been made from the cracked shale oil by acid and caustic treatment. Better quality diesel fuels are prepared by hydrogenation of a coker distillate. Even better quality diesel fuels have been made by hydrocracking of a crude shale oil from underground in-situ retorting experiments. S.D.

**A76-47299 # The combustion of shale derived marine diesel fuel at marine gas turbine engine conditions.** M. C. Hardin (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 152-177. 6 refs. Contract No. N00024-76-C-5309.

**A76-47300 # Current developments in oil shale research at the Laramie Energy Research Center.** I. A. Jacobson, Jr., E. L. Burwell, A. E. Harak, A. Long, and R. L. Wise (ERDA Energy Research Center, Laramie, Wyo.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 211-225. 5 refs.

The paper discusses the current retorting research projects of the oil shale conversion group at the Laramie Center. These projects include the concurrent production of usable gas and oil during oil shale retorting, the effects of retorting atmosphere and pressure on oil shale retorting, the retorting of oil shale in an aboveground batch retort, and current in-situ retorting field problems. Quantitative production data are provided. A current true in-situ field test is in progress. The oil shale formation has been fractured and a recovery experiment started. S.D.

**A76-47301 # Paraho Oil Shale Project.** H. Pforzheimer (Paraho Development Corp., Anvil Points, Colo.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 236-239.

The Paraho Oil Shale Project is a privately financed program to prove the Paraho retorting process and hardware on oil shale at Anvil Points, Colo. The developmental stages of the underlying program are discussed in terms of a pilot plant and a semi-works size unit. During a confirming indirect heated run, a series of evolutionary changes in operating conditions were made which reduced the heat input required per ton of shale, thereby increasing thermal efficiency. Retort performance is shown to exemplify simplicity in process and mechanical design. An acceptable basis is demonstrated for initiating government financial support for continued operation. S.D.

**A76-47302 # Oil shale conversion by hydrogasification.** F. C. Schora, Jr. (Illinois Institute of Technology, Chicago, Ill.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 240-249.

A new process has been developed for converting oil shale to pipeline gas by direct hydrogasification. This process uses counter-current shale/hydrogen contacting and excess hydrogen. Laboratory- and bench-scale tests have demonstrated that as much as 95 per cent of the organic matter in the shale can be converted to useful products. Along with results obtained in early testing, the design of a 1-ton-per-hour process development unit (PDU) is discussed, as are commercial process concepts. The shakedown of the PDU, built under sponsorship of the American Gas Association (A.G.A.) at the IGT pilot plant site in Chicago, was completed in May (1976) and testing began immediately. Several patents covering this process and its variants have been issued to IGT and assigned to A.G.A. (Author)

**A76-47303 # A review of the use of methanol as a motor vehicle fuel.** P. E. Cassady (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 257-272. 46 refs.

The paper is concerned with the performance of vehicles fueled with methanol either in blends or pure, the problems associated with the driveability of such fuels, the possibility of corrosion and incompatibility of these fuels with automotive systems components, the vehicle modifications indicated (if necessary), and the effect of the use of these fuels on exhaust emissions. The blending of methanol with gasoline is shown to boost the octane number of the gasoline without the use of tetraethyl lead and to reduce the emission of air pollutants from unmodified automobile engines. The use of pure methanol as a motor vehicle fuel eliminates most of the problems encountered with the use of blends, although certain vehicle modifications become necessary. There are no basic technical obstacles to use methanol as a motor vehicle fuel. The problems to be solved involve design details that will be resolved through experience that can be gained during fleet tests. S.D.

**A76-47305 # Motor gasoline from shale oil.** P. L. Cottingham (ERDA Energy Research Center, Laramie, Wyo.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 281-293. 10 refs.

Shale oil produced from oil shale of the Rocky Mountain region by many of the usual retorting processes consists mainly of high boiling compounds of nitrogen, sulfur, and oxygen; less than half of the oil consists of hydrocarbons. Thermal cracking of the oil followed by acid and caustic treating of the gasoline fraction has produced stable gasolines with low to moderate octane numbers. Hydrogenating the raw crude oil has produced higher yields of stable gasolines, also with low to moderate octane numbers. The yields and octane numbers of the gasolines are dependent on the hydrogenation temperatures used. Low-octane hydrogenated gasoline has been catalytically reformed over platinum-containing catalyst to produce high-octane motor fuel. (Author)

**A76-47306 # Economy of hydrogen-fueled automobile engines.** D. B. Mackay (Billings Energy Research Corp., Provo, Utah). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 294-301.

Considerable reduction in energy consumption is possible for engines using hydrogen fuel, as compared to those using gasoline. Hydrogen engines can be made with high compression ratios, and thus can attain high thermal efficiencies at all loads and speeds. In addition, it is possible to vary hydrogen-air mixture ratios to achieve load control. Lean mixtures at part loads improve thermodynamic performance and reduce pumping losses. For these reasons considerable energy savings are possible, particularly at part loads and lower speeds. The engine used for comparison showed approximately

a 20 per cent increase in mileage per unit of energy at 60 miles per hour, and double mileage at 20 miles per hour. These results have been substantiated on an automobile tested at Billings Energy Research Corporation. This economy is possible while creating essentially no atmospheric pollution. (Author)

**A76-47307 # Alternate auto fuels.** A. J. Zaehring (Azex Co., Birmingham, Mich.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 306-314. 26 refs.

The present consumption and characteristics of auto engine fuels which are about 95% petroleum-derived are reviewed. The characteristics of these fuels and the present and projected prices of nonfuel applications will seriously hamper the expansion of the market. Alternate fuels considered are hydrogen, metal hydrides, light hydrocarbon fuels, heavier fractions, alcohols, and solid fuels. Environmental problems must be considered in any alternate fuel. NO<sub>x</sub> and possibly SO<sub>x</sub> will pose serious problems for any air-consuming engine. The continued buildup of CO<sub>2</sub> levels in the atmosphere may well call for a complete ban on combustion engines. The economics of the fuels, including coal-derived syncrudes, will limit the use of any fuel. It is concluded that there are only three alternate fuels of any potential for the remainder of this century: hydrogen, gasoline (whether based on imports or from domestic coal), or the direct utilization of coal in engines. (Author)

**A76-47308 # Development of a sodium borohydride hydrogen fuel storage system for vehicular applications.** C. A. MacCarley (California, University, Los Angeles, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 315-321. 22 refs.

An investigation of the application of boron-hydrogen compounds as hydrogen carriers is made. The ionic solid, sodium borohydride, demonstrates advantage over others in its high hydrogen density, safety of storage, and ease of decomposition. Several systems are designed to generate hydrogen gas from this chemical with a controllability and compactness compatible with projected vehicular use constraints. Data generated in the development and testing of these systems defines design parameters to be optimized and methods for these optimizations, indicating an ideal design for a roadable sodium borohydride hydrogen-storage system. Comparative system feasibility is discussed. (Author)

**A76-47309 # R&D in the conversion of solid organic wastes to high octane gasoline.** J. P. Diebold, C. B. Benham, and G. D. Smith (U.S. Naval Weapons Center, China Lake, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 322-325. 9 refs.

A process has been identified which converts the organic fraction of municipal solid waste to a valuable product. The process involves the selective pyrolysis of solid wastes to form gaseous unsaturated hydrocarbons (ethylene and propylene), by-product gases, and char. After compression and purification, the unsaturated gaseous hydrocarbons are noncatalytically polymerized to yield a mixture of gasoline and oils. The products that are formed are 90% high octane gasoline and about 10% fuel and lubricating oils which can be easily marketed. The overall conversion of solid waste energy to gasoline and fuel oils appears to be about 60%, based on data reported in literature. Present efforts are directed toward the verification of these reported values, particularly in the area of pyrolysis. S.D.

**A76-47310 # Coal gasification - A new alternative in clean energy production.** B. A. King (Western Gasification Co., Los Angeles, Calif.). In: Symposium on Alternate Fuel Resources, Santa

Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 331-338.

Coal is the most abundant fossil fuel in the USA and gasification is the best suited method of treating coal to obtain combustible gases with subsequent upgrading. Attention is focused on the Lurgi gasification process which consists of a series of steps that successively take sized coal, gasify the coal, reject the ash, clean and cool the gas, increase the heating value by methanation, and then compress the product SNG into the pipeline. The overall procedures for the plant are mining, transportation, coal preparation, gasification, purification, and by-product recovery. The first section of the gasification process is the commercially-proven Lurgi gas producer, where the gas is produced by the reaction of coal and oxygen in the presence of excess steam in a suitable reactor at a pressure of 400 to 450 psig. Other topics discussed include utilities and non-Lurgi process, plant layout, and cost and impact of project. S.D.

**A76-47311 # The catalytic hydrocracking of coal derived oils.** L. Berg (Montana State University, Bozeman, Mont.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 339-342. ERDA-sponsored research.

Preliminary results are presented for a program designed to take the product from the most advanced coal liquefaction processes and convert it catalytically to a clean distillate fuel, where the term distillate is understood to mean anything that has been vaporized and recondensed leaving the nonvaporizable material behind. Chemical characteristics of coal are outlined in order to gain a better insight into the problems of making acceptable liquid fuels from coal. Advanced liquefaction processes are described which furnish the raw material for catalytic upgrading studies. Particular attention is given to the catalytic treatment of liquefied coals to further upgrade them. The reactors designed consist of a 1-in. steel tube inserted in an aluminum cylinder, where an electric winding around the aluminum cylinder provides heat. An analysis of candidate catalysts revealed that nickel-tungsten is a proper approach. S.D.

**A76-47312 # Desulfurization of coal-oil mixtures by attrition grinding with activated iron powder.** F. J. Hendel (California Polytechnic State University, San Luis Obispo, Calif.) and J. Winkler. In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 357-371. 10 refs.

Most USA coals and petroleum fuel oils, both the distillate and the residual ones, contain an excessive amount of sulfur and cannot be used unless the sulfur and/or SO<sub>2</sub> are removed so that the stack gases are clean. Results are presented for an experimental study in which high-bituminous coal mixed with fuel oil and iron powder followed by grinding in a laboratory ball mill at 250 C lost about 50% of sulfur in the first 5 min. It is shown that attritional grinding with iron powder dispersed in a heavy mineral oil gives a higher degree of total sulfur removal than conventional mixing (agitation). For best sulfur elimination from coal, the dispersing oil should predominantly contain aromatic compounds. Conceptual design of large-scale operation is discussed relative to overall flow of materials, desulfurizer, continuous centrifuge, and regeneration of iron powder. The slurry of desulfurized coal and fuel oil can be distributed by tank cars, tankers, and pipelines. S.D.

**A76-47313 # Environmental problems encountered in shale oil production.** J. W. Davidson (USAF, Aerospace Fuels Laboratory, Vandenberg AFB, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 373-381. 12 refs.

The paper presents a review of environmental control technologies in shale oil production with a view toward establishing a reference base against which environmental impacts can be evaluated. Particular attention is given to factors important to the assessment and control of environmental impacts that would result from commercial operations. These include management of solid wastes and disturbed areas, management of wastes within the working areas, environmental control during aboveground and in-situ processing and monitoring. Plants for the recovery of specific minerals and manufacture of appropriate products may cause additional environmental problems in the future. S.D.

**A76-47315 # Solid waste as an alternative for power and heat generation - A state of the art review.** C. F. King and L. C. Stuckenbruck (Southern California, University, Los Angeles, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 403-415. 39 refs.

Conservative estimates show that the theoretical potential of energy from municipal solid waste is equal to five per cent of the fuel required by all of the utilities in the United States; the energy that could be recovered is equivalent to 28% of the oil produced for delivery through the Alaskan pipeline. In the present paper, the current status of systems which will recover energy from solid waste is reviewed, grouping the systems into four categories: direct utilization of unprepared waste; utilization of separated waste; pyrolysis; and biomass conversion. The possibilities of future development and expansion are examined with a view toward selection and implementation of a system and the marketing and saleable energy recovered. V.P.

**A76-47316 # The politics of energy.** C. L. Stone. In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 416-420.

The Joint Committee on Job Development, California Legislature, introduced in January 1976 two Senate bills on prototype facilities for energy recovery from solid waste. The bill SB 1395, supported by SB 1396 as a statewide bonding act, if approved by the California Governor and the voters, would create a vast number of new jobs, solve the problem of solid waste disposal, and add new resources of energy in California. Sale of the energy would pay for retiring the bonds. (Author)

**A76-47317 # Agricultural wastes as a source of energy.** P. Maciel (Pacific Gas and Electric Co., San Francisco, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 421-433.

The types of agricultural waste, which could represent an environmentally acceptable energy source, are rice straw, cotton residue, and cattle manure. In the present paper, particular attention is given to the collection, transportation, and storage of such wastes, because the economics of collection and transportation may be the major obstacle to the conversion of agricultural wastes to clean fuels or electricity. Conversion technologies currently being evaluated for processing agricultural wastes and manure into a usable form of energy include: direct combustion, direct combustion as fuel, supplement for a coal-fired plant; conversion to fuel gas; and anaerobic digestion to produce methane or substitute natural gas. V.P.

**A76-47318 # Methane recovery from landfills.** D. L. Calden (Pacific Gas and Electric Co., San Francisco, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 434-442.

Under present conditions, the liability associated with methane gas produced by decomposition of refuse in landfills can become a valuable asset. Twenty four of the thirty two existing landfills in the San Francisco Bay area have, been estimated to be capable of producing 1 million standard cubic feet of gas per day each. Over their useful lifetimes, these landfills could provide the equivalent of 8 million barrels of fuel oil. The different modes of utilization of landfill gas examined in the present paper include: injection of gas into existing transmission lines; sales of gas to nearby interruptible customers; on-site conversion to methanol; on-site power generation; and on-site conversion to liquified natural gas. V.P.

**A76-47319 # Preliminary economics of trash to gasoline plants.** G. D. Smith, C. B. Benham, and J. P. Diebold (U.S. Naval Weapons Center, China Lake, Calif.). In: Symposium on Alternate Fuel Resources, Santa Maria, Calif., March 25-27, 1976, Proceedings. North Hollywood, Calif., Western Periodicals Co.; Vandenberg, Calif., American Institute of Aeronautics and Astronautics, Inc., 1976, p. 443-448. 8 refs.

A preliminary study of capital and operating costs of plants to convert municipal solid waste to gasoline is presented. The assumed conversion plant is comprised of (1) a front-end system for separating the organic fraction of the solid-waste stream from metals and glass, (2) a pyrolysis section for production of low-molecular-weight unsaturated hydrocarbons (ethylene, propylene, butenes), and (3) a polymerization system for gasoline synthesis. Capital costs were obtained for each of the subsystems for a specific capacity, and operating costs were estimated for each of the three systems. Total net operating costs per ton of raw trash processed were obtained as functions of plant capacity and value derived from the gasoline product. The results indicate that a municipally owned plant serving a metropolitan area of 50,000 population would break even at a gasoline value of about \$.50 per gallon (\$.13/liter) (assuming a credit of \$5 per ton (\$5.50/tonne) for a dumping fee). The total capital investment for this installation would be about 4.5 million dollars. (Author)

**A76-47437 Thermal energy storage unit based on lithium fluoride.** G. A. A. Asselman (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). *Energy Conversion*, vol. 16, no. 1-2, 1976, p. 35-47. 9 refs.

A thermal energy storage unit employing lithium fluoride has been built to supply heat to a Stirling engine. The heat transport from the electric heating elements to the heat storage unit and from the latter to the heat sink is affected by the evaporation and condensation of sodium. The liquid sodium is transported with the aid of capillary structures, so that the system of heat transfer has the characteristics of a heat pipe. The experience gained with the storage unit built combined with later developments in the heat-pipe field and in the use of anti-corrosion inhibitors for the salt, have led to more sophisticated designs, which are described. (Author)

**A76-47438 A comparison of hydrogen with alternate energy forms from coal and nuclear energy.** K. E. Cox (New Mexico, University, Albuquerque, N. Mex.). *Energy Conversion*, vol. 16, no. 1-2, 1976, p. 49-54. 7 refs.

Alternate energy forms that can be produced from coal and nuclear energy have been analyzed on efficiency, economic and end-use grounds. These forms include hydrogen, methane, electricity, and EVA-ADAM, a 'chemical heat-pipe' approach to energy transmission. The EVA-ADAM system for nuclear heat appears to be economically competitive with the other energy carriers except over very large distances. The cost of hydrogen derived from coal is approximately equal to that of methane derived from the same source when compared on an equal BTU basis. Thermochemically derived hydrogen from nuclear energy shows a break-even range with hydrogen derived from coal at coal costs of from \$33-80/ton depending on the cost of nuclear heat. Electricity and electrolytically derived hydrogen are the most expensive energy carriers and electricity's use should be limited to applications involving work

rather than heat. Continued work in thermochemical hydrogen production schemes should be supported as an energy option for the future. (Author)

**A76-47440** Performance analyses of combined heating and photovoltaic power systems for residences. M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *Energy Conversion*, vol. 16, no. 1-2, 1976, p. 79-90. 6 refs.

The performance of a combined solar heating and photovoltaic electric power generation system for a single family residence was analyzed over a full year using hourly US Weather Bureau data for insolation and environmental temperature for Boston, 1963. The system considered was a silicon solar array mounted inside a stationary flat plate collector using a lead-acid battery as the storage element. The principal result of the analysis is the overall system performance summarized in a table. B.J.

**A76-47695** Solar energy conversion - The chemical viewpoint. K. W. Boer (Delaware, University, Newark, Del.). *Resource Recovery and Conservation*, vol. 2, Aug. 1976, p. 5-21. 76 refs.

The paper reviews solar energy conversion technology with attention given to photochemical reactions (biconversion to fuels, and thermochemistry), direct conversion of sunlight into electricity (thermoelectric and photovoltaic conversion). The Solar One concept of deploying solar cells for heat and electricity is illustrated by the example of the Delaware Solar One house. Economic aspects of solar energy conversion are discussed and schedules are presented for possible large scale deployment. B.J.

**A76-47708 \*** Public policy for solar heating and cooling. A. S. Hirshberg (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.; Environmental Future, Inc.). *Bulletin of the Atomic Scientists*, vol. 32, Oct. 1976, p. 37-45. 15 refs.

Recent analyses indicated that solar heating and cooling systems for residential buildings are nearly economically competitive with conventional fossil fuel or electric systems, the former having higher initial cost but a lower operating cost than the latter. The paper examines obstacles to the widespread acceptance and use of solar space conditioning systems and explores some general policies which could help to overcome them. The discussion covers such institutional barriers limiting the adoption of solar technologies as existing building codes, financing constraints, and organizational structure of the building industry. The potential impact of financial incentives is analyzed. It is noted that a tax incentive of 25% could speed the use of solar energy by 7 to 8 years and produce an 8% reduction in fossil fuel use by 1990. A preliminary incentive package which could be helpful in promoting solar energy both at federal and state levels is proposed, and the necessary incentive level is analyzed. S.N.

**A76-47709** The outlook for underground coal gasification. L. A. Schrider, C. F. Brandenburg, D. D. Fischer, R. M. Boyd, and G. G. Campbell (ERDA Laramie Energy Research Center, Laramie, Wyo.). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 29, Sept. 1976, p. 409-415. 14 refs.

Underground coal gasification (UCG) could possibly play an important role in making the U.S. energy self-sufficient. Of the estimated 3200 billion short tons of coal resource, only 12% is considered economically recoverable using current coal mining technology. Approximately 1600 billion tons is too deep or of poor quality. With the aid of UCG this coal can be processed to obtain a low-Btu gas for direct use in power generation. An experiment was conducted to study the feasibility of UCG in a thick, western subbituminous coal seam. The energy produced in the experiment during a 5 1/2-month period was sufficient to generate approximately 1 MWe of power. A second experiment is in progress using pneumatic linking to increase permeability between wellbores. G.R.

**A76-47710 #** Energy and the environment (*Energetika a životní prostředí*). M. Bezacinsky (Ustav pro Vyzkum a Využití Paliv, Prague, Czechoslovakia). *Energetika*, vol. 26, Aug. 1976, p. 344-348. In Czech.

Arsenic traces in carbon-containing combustion products constitute the center of attention of the study, which also touches upon copper, zinc, and fluorine or fluorocarbons accompanying carbon-containing combustion products. Caution is recommended in using the Cu and Zn pollutant data, being the first of their kind in the literature. Pollutant particulates were sampled from boiler fly ash, centrifugal screens and classifiers, and mechanical and electrostatic separators. Tabular data are presented on mesh size distribution, pollutant source (coal, fly ash, slag or cinders, process volatiles), and trace elements present. R.D.V.

**A76-47711 #** How to determine the guaranteed efficiency and output of hydroelectric power stations (*Stanovenie zabezpečeneho výkonu a výroby vodných elektrární*). V. Ondrusek (Vyskumny Ustav Energetický, Bratislava, Czechoslovakia). *Energetika*, vol. 26, Aug. 1976, p. 369, 370. 5 refs. In Slovak.

The guaranteed output of a hydroelectric plant is defined and its major deterministic and stochastic components are presented. Determinateness and randomness of loads on power plants, cyclic regularities over periods of time, average loads by time period or time of year, regulation of large storage basins and impounding reservoirs, and restraints placed on power station operation by the needs of the national economy are discussed with attention given to computational considerations, simplified assumptions in models, and limitations on predictions based on earlier trends in power consumption patterns. Daily average and monthly average flowrates for different times of year are considered most useful. Water stream diversions, more regular for industrial purposes and more erratic for agricultural purposes and irrigation, are taken into cognizance. R.D.V.

**A76-47712 #** Simulation of nonlinearities with the aid of mixed-integral linear optimization and its application in the energy economy (*Simulierung von Nichtlinearitäten mit Hilfe der gemischt-ganzzahligen linearen Optimierung und ihre Anwendung in der Energiewirtschaft*). G. Heil (Kammer der Technik, Institut für Energieversorgung, Dresden, East Germany). *Energetika*, vol. 26, Aug. 1976, p. 349-353. 6 refs. In German.

A description is presented of an approach for the piecewise linearization of cost functions with arbitrary curvature characteristics, taking into account mixed-integral optimization methods. Attention is given to the basic forms of a cost function, the method of mixed-integral optimization as an aid in the solution of minimization problems with a concave cost function, and an evaluation of the results obtained in an application of the considered approach. G.R.

**A76-47713** Preparing bituminous coals for gasification. P. J. Gard, H. J. Maxwell (Fluor Utah, Inc., San Mateo, Calif.), and J. F. Mullowney (Fluor Engineers and Constructors, Inc., Los Angeles, Calif.). *Coal Mining and Processing*, vol. 13, Sept. 1976, p. 61-64.

A number of techniques for preparation (beneficiation) of coal for gasification are discussed. Attention is given to the effective modification of the following coal characteristics: the size distribution and mean particle size, total moisture content, the ash content, the sulfur content, and the Btu content (heat value). It is found that cost benefits from coal preparation can be very significant. B.J.

**A76-47717** Geothermal chemical engineering. R. C. Axtmann and L. B. Peck (Princeton University, Princeton, N.J.). *AIChE Journal*, vol. 22, Sept. 1976, p. 817-828. 142 refs.

Programs, projects, and research for utilization of geothermal energy are reviewed from a chemical engineering vantage point, with

attention given to costs, proved resources, reservoir models, applications, and environmental impact. Neglect of crucial chemical reactions occurring in geothermal systems impair the usefulness of existing models constructed for hydrothermal reservoirs. Currently entertained models, studies of reservoir mechanics and ground water hydrology, well drilling and flow optimization, two-phase flow in geothermal wells, downhole heat exchangers, and production of geoheat are reviewed. Applications of geoheat in the US, Iceland, Hungary, USSR, and New Zealand are mentioned, with discussion of process heat for chemical and metallurgical process industries, production of electric power from geothermal sources, extraction of minerals from geothermal waters, and geothermal desalination plants. Corrosion and scaling, gas emissions, aqueous effluents, and reinjection of spent geothermal fluids are discussed.

R.D.V.

**A76-47751 #** **Converting solar radiation to heat - Challenges to optical material science.** B. O. Seraphin (Arizona, University, Tucson, Ariz.). *Optical Sciences Center Newsletter*, vol. 10, June 1976, p. 6-16. 30 refs.

It is shown that in the conversion of solar radiation to heat, the optical properties of the surface intercepting the solar flux are of key importance for conversion efficiency. The proper spectral selectivity for a photothermal converter is high absorption over the spectral range of the solar emission, combined with minimized reradiation loss across the thermal infrared range. The selection of a number of materials as reflector and absorber surfaces, including hafnium carbide, metals such as Au, Ag, Cu and Al, transition metal oxides (with particular attention given to rhenium trioxide) is discussed. The use of semiconductors as solar absorbers is also considered along with selectivity by wavefront discrimination.

B.J.

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## STAR ENTRIES

**N76-28203\*#** United Technologies Research Center, East Hartford, Conn.

**COST/BENEFIT TRADE-OFFS FOR REDUCING THE ENERGY CONSUMPTION OF COMMERCIAL AIR TRANSPORTATION (RECAT) Final Report**

F. W. Gobetz and A. P. Dubin Jun. 1976 200 p refs  
(Contract NAS2-8608)

(NASA-CR-138877; UTRC-R76-912036-16) Avail: NTIS HC \$7.50 CSCL 01C

A study has been performed to evaluate the opportunities for reducing the energy requirements of the U.S. domestic air passenger transport system through improved operational techniques, modified in-service aircraft, derivatives of current production models, or new aircraft using either current or advanced technology. Each of the fuel-conserving alternatives has been investigated individually to test its potential for fuel conservation relative to a hypothetical baseline case in which current, in-production aircraft types are assumed to operate, without modification and with current operational techniques, into the future out to the year 2000. Author

**N76-28204\*#** United Technologies Research Center, East Hartford, Conn.

**COST/BENEFIT TRADE-OFFS FOR REDUCING THE ENERGY CONSUMPTION OF COMMERCIAL AIR TRANSPORTATION (RECAT) Summary Report**

F. W. Gobetz and A. A. LeShane Jun. 1976 43 p  
(Contract NAS2-8608)

(NASA-CR-137878; UTRC-R76-912036-17) Avail: NTIS HC \$4.00 CSCL 01C

The RECAT study evaluated the opportunities for reducing the energy requirements of the U.S. domestic air passenger transport system through improved operational techniques, modified in-service aircraft, derivatives of current production models, or new aircraft using either current or advanced technology. Each of these fuel-conserving alternatives was investigated individually to test its potential for fuel conservation relative to a hypothetical baseline case in which current, in-production aircraft types are assumed to operate, without modification and with current operational techniques, into the future out to the year 2000. Consequently, while the RECAT results lend insight into the directions in which technology can best be pursued for improved air transport fuel economy, no single option studied in the RECAT program is indicative of a realistic future scenario. Author

**N76-28638** Texas Univ., Austin.

**GEOLOGIC HABITATS OF GEOTHERMAL ENERGY AND METHODS OF EXPLORATION Ph.D. Thesis**

Myron Herbert Dorfman 1975 244 p  
Avail: Univ. Microfilms Order No. 76-14437

The worldwide distribution of geothermal resources is classified within the framework of plate tectonics. Reservoir rocks, cap rocks, and fluid characteristics indigenous to various tectonic settings are described. These include continental subduction systems, island arc subduction systems, crustal rift systems, convective mantle plume systems, and geopressed sedimentary basins. Various geophysical techniques under current investigation

for identifying and delineating geothermal reservoirs are described with particular emphasis on the self-potential method. Theories of the self-potential method of geophysical exploration are discussed, and results of laboratory and field tests of the self-potential method in geothermal exploration are described. Self-potential surveys appear to be an excellent tool for delineating areas of high heat flow beneath the surface. Field tests indicate that self-potential surveys also represent an important new technique for determining the magnitude and direction of heat movement in thermal floods of petroleum reservoirs.

Dissert. Abstr.

**N76-28647\*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. **THE COST OF ENERGY FROM UTILITY-OWNED SOLAR ELECTRIC SYSTEMS. A REQUIRED REVENUE METHODOLOGY FOR ERDA/EPRI EVALUATIONS**

Jun. 1976 89 p refs Sponsored in part by ERDA

(Contract NAS7-100)

(NASA-CR-148493; JPL-5040-29; ERDA/JPL-1012-76/3)

Avail: NTIS HC \$5.00 CSCL 10A

This methodology calculates the electric energy busbar cost from a utility-owned solar electric system. This approach is applicable to both publicly- and privately-owned utilities. Busbar cost represents the minimum price per unit of energy consistent with producing system-resultant revenues equal to the sum of system-resultant costs. This equality is expressed in present value terms, where the discount rate used reflects the rate of return required on invested capital. Major input variables describe the output capabilities and capital cost of the energy system, the cash flows required for system operation and maintenance, and the financial structure and tax environment of the utility. Author

**N76-28650#** Committee on Science and Technology (U. S. House).

**SOLAR SATELLITE POWER SYSTEM CONCEPTS**

Washington GPO 1976 656 p refs Hearings before Subcomm. on Space Sci. and Applications and the Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr., 2d Sess., No. 67, 20 Feb. 1976

(GPO-71-588) Avail: Subcomm. on Space Sci. and Applications

Project planning and conceptual designs are outlined for an orbiting solar satellite power station which will transmit solar energy in the form of microwaves to earth ground stations where it will be converted to electricity. Topics discussed are: (1) control systems for the station (on the ground and in space), (2) maintenance of the station, (3) materials selection, (4) dynamic structural analysis (mathematical models), (5) various components used in the station (i.e., microwave antennas), (6) research and development costs, and in-space construction costs for the station, (7) orbital calculations and launch vehicles for the station, and (8) biological effects of microwaves on humans and animals, and the heat effects of microwaves on the earth's atmosphere. Photographs and diagrams of the proposed solar satellite power station and ground stations are shown. J.R.T.

**N76-28652\*#** Western New Mexico Univ., Silver City.

**AN INVESTIGATION OF THE ACCEPTANCE OF SOLAR HEATING AND COOLING IN THE HOUSING INDUSTRY IN NEW MEXICO Final Technical Report, 1 Aug. 1975**

31 Jul. 1976

Craig R. Lundahl, James Calvert Scott, and David M. Dennis 31 Jul. 1976 286 p

(Grant NSG-902)

(NASA-CR-148528) Avail: NTIS HC \$9.25 CSCL 10A

A data base of information relating to the acceptability of solar-energy technology in the New Mexican housing industry was developed. Topics examined include: (1) the factors which influence the adoption of solar-energy systems in the New Mexican housing industry; (2) the degree of acceptability of various solar factors among New Mexican consumers, architects, contractors, financiers, energy suppliers, and governmental officials; and (3) the current attitudes toward the acceptability of solar energy factors in the New Mexican housing industry.

Author



**N76-28661#** Interagency Task Force on Synthetic Fuels, Washington, D. C.

**RECOMMENDATIONS FOR A SYNTHETIC FUELS COMMERCIALIZATION PROGRAM. VOLUME 1: OVERVIEW REPORT**

Nov. 1975 215 p refs Sponsored by ERDA and Energy Resources Council.

(PB-249445/8; FEA/B-76/046-Vol-1) Avail: NTIS HC \$5.50 HC also available in set of 4 reports as PB-249444-SET HC \$60.00 CSCL 10A

An interagency Task Force was formed to examine alternatives for assuring early commercialization of synthetic fuels in the United States. The results of the Task Force's efforts are summarized in this overview. The analyses included consideration of: the economic and environmental costs and benefits associated with alternative programs for accelerating synthetic fuels commercialization; alternative incentives which might be offered by the Federal Government including their effectiveness and cost; and measures needed for expeditious implementation of a program assuming a decision is made to proceed. GRA

**N76-28662#** Interagency Task Force on Synthetic Fuels Washington, D. C.

**RECOMMENDATIONS FOR A SYNTHETIC FUELS COMMERCIALIZATION PROGRAM. VOLUME 2: COST/BENEFIT ANALYSIS OF ALTERNATE PRODUCTION LEVELS**

Nov. 1975 362 p refs Sponsored by ERDA and the Energy Resources Council

(PB-249446/6; FEA/B-76/047-Vol-2) Avail: NTIS HC \$10.50; HC also available in set of 4 reports as PB-249444-SET HC \$60.00 CSCL 10A

This report examines alternatives for implementing the President's goal of assuring early commercialization of synthetic fuels in the United States. The cost/benefit analysis addressed the question of whether the Federal Government should accelerate the commercial production of synthetic fuels and, if so, at what rate. Specifically, the alternative program levels evaluated in this report are: (1) No Program - no Federal involvement in a commercialization program, but continuation of research and development and normal investment decisions by U.S. industry. (2) Information Program - Federal involvement designed to assist in the establishment of the equivalent of 350,000 barrels per day in capacity. (3) Medium Program - designed to produce approximately 1,000,000 barrels per day. (4) Maximum Program - designed to produce approximately 1,700,000 barrels per day. GRA

**N76-28663#** Interagency Task Force on Synthetic Fuel: Washington, D. C.

**RECOMMENDATIONS FOR A SYNTHETIC FUELS COMMERCIALIZATION PROGRAM. VOLUME 3: TECHNOLOGY AND RECOMMENDED INCENTIVES**

Nov. 1975 982 p refs Sponsored by ERDA and the Energy Resources Council

(PB-249447/4; FEA/B-76/048-Vol-3) Avail: NTIS HC \$23.75 HC also available in set of 4 reports as PB-249444-SET HC \$60.00 CSCL 10A

This report presents the technology and incentives recommended to establish a commercially viable Synthetic Fuels Commercialization Program (SCP) directed toward achieving the President's goal of one million barrels of crude oil equivalent per day in 1985. Analysis of each incentive considers its ability to meet the following criteria: effectiveness, competitiveness, administrative feasibility, federal involvement, flexibility, breadth of participation, existing authority, and contingency analyses. Availability of energy producing raw materials such as coal, shale, and biomass waste and the market for synthetic fuels is covered. Portions of this report are not fully legible. GRA

**N76-28664#** Interagency Task Force on Synthetic Fuels, Washington, D. C.

**RECOMMENDATIONS FOR A SYNTHETIC FUELS COMMERCIALIZATION PROGRAM. VOLUME 4: DRAFT ENVIRONMENTAL IMPACT STATEMENT**

Dec. 1975 986 p refs Sponsored by ERDA and the Energy Resources Council

(PB-249448/2; FEA/B-76/049-Vol-4) Avail: NTIS HC \$23.75; HC also available in set of 4 reports as PB-249444-SET, HC \$60.00 CSCL 10A

The President announced a Synthetic Fuels Commercialization Program to accelerate the production of synthetic fuels from coal, oil shale and solid wastes. This Draft Environmental Impact Statement presents a generic assessment of the potential environmental impacts associated with the undertaking of this Program. GRA

**N76-28665#** Nottingham (H. D.) and Associates, Inc., McLean, Va.

**REVIEW AND ANALYSIS OF NATIONAL ENERGY RESEARCH AND DEVELOPMENT PROGRAMS AND PROPOSALS Final Report**

T. Singh and J. S. Soni Jan. 1976 437 p

(Contract DAAG53-75-C-0233)

(AD-A020794; USAFESA-RT-2006) Avail: NTIS CSCL 10/1

Tabulated and analyzed in this report are recently completed and on-going energy R and D programs by pertinent governmental and industrial organizations. The five major areas of discussion in this study include: nuclear fission; renewable energy resources; conversion systems; energy conservation; and multi-directional energy R and D studies. Outlined are the state-of-the-art; established national goals and objectives; nature of R and D studies currently underway; and recommendations for future R and D work by the U.S. Army. GRA

**N76-28666#** Army Facilities Engineering Support Agency, Fort Belvoir, Va. Research and Technology Div.

**ENERGY CONSERVATION OUTLINE Interim Report**

Casimir A. Kukiela 1 Dec. 1975 19 p refs

(AD-A020139; RT-2007) Avail: NTIS CSCL 10/1

A compilation of energy conservation ideas and concepts obtained from a review of manuals, guidelines, reports, letters and memos from several government agencies and private industry is presented. The outline is broken down into major categories where these energy conservation techniques may lead to reduced energy consumption. Examples are used for clarity, to show possible savings and to stimulate new conservation concepts and ideas. GRA

**N76-28667#** Dubin-Mindell-Bloome Associates, New York. **GUIDELINES FOR SAVING ENERGY IN EXISTING BUILDINGS. ENGINEERS, ARCHITECTS, AND OPERATORS MANUAL, ECM 2**

Fred S. Dubin, Harold L. Mindell, and Selwyn Bloome 16 Jun. 1975 434 p refs

(Contract DI-14-01-0001-1844)

(PB-249929/1; FEA/D-75/358; FEA/D-CP-21) Avail: NTIS HC \$11.75 CSCL 13A

Energy conservation measures which can result in further energy savings of 15 to 20% with an investment cost that can be recovered within 10 years through lower operating expenses are discussed. GRA

**N76-28668#** Dubin-Mindell-Bloome Associates, New York. **GUIDELINES FOR SAVING ENERGY IN EXISTING BUILDINGS. BUILDING OWNERS AND OPERATORS MANUAL, ECM 1**

Fred S. Dubin, Harold L. Mindell, and Selwyn Bloome 16 Jun. 1975 282 p refs

(Contract DI-14-01-0001-1844)

(PB-249928/3; FEA/D-75/359; FEA/D-CP-20) Avail: NTIS HC \$9.25 CSCL 13A

National energy usage in existing commercial buildings, methods of reducing energy consumption through conservation, and the resulting costs and benefits are examined. A wide range of opportunities and options to save energy and operating costs through proper operation and maintenance are discussed. Minor modifications to the building and mechanical and electrical systems, which can be implemented promptly with little if any investment costs, are included. GRA

**N76-28669#** Mathematica, Inc., Princeton, N.J.  
**COMPREHENSIVE EVALUATION OF ENERGY CONSERVATION MEASURES Final Report**  
 Dilip R. Limaye, John R. Sharko, Jeffrey P. Price, and Joseph A. Orlando Mar. 1976 449 p refs  
 (Contract EPA-68-01-2440; EPA-68-01-2445)  
 (PB-250824/0; EPA-230/1-75-003) Avail: NTIS HC \$11.75  
 CSCL 13A

An analysis of the relative social, economic, and environmental impacts and energy savings associated with thirty proposed energy conservation measures is presented. Residential, commercial, industrial, power generation and transportation energy consumption are covered. Projections are national for the years 1977, 1980, 1985, and 1990. A ranking of measures compares the relative costs and effectiveness of measures. The methodology can be adapted to a variety of situations. GRA

**N76-28670#** Mathematica, Inc., Princeton, N.J.  
**COMPREHENSIVE EVALUATION OF ENERGY CONSERVATION MEASURES, APPENDICES Final Report**  
 Dilip R. Limaye, John R. Sharko, Jeffrey P. Price, and Joseph A. Orlando Mar. 1975 143 p refs  
 (Contracts EPA-68-01-2440; EPA-68-01-2445)  
 (PB-250825/7; EPA-230/1-75-004) Avail: NTIS HC \$6.00  
 CSCL 13A

Appendices provide detailed methodology, data base and technical discussions in the areas of energy consumption, space heating, hot water heating, heat pumps, and total energy systems. GRA

**N76-28672#** RMC Research Corp., Bethesda, Md.  
**INTERCITY PASSENGER TRANSPORTATION: MODE/ENERGY CONSERVATION. VOLUME 2: ANALYSIS Final Report**  
 George Roche and Armando M. Lago Dec. 1975 325 p refs  
 (Contract EQ4AC028)  
 (PB-250884/4; RMC-UR-286-Vol-2; EQ-5174130282-Vol-2).  
 Avail: NTIS CSCL 10A

Contents: Intercity passenger data; Development of intercity passenger demand models; Energy conservation policies and their impacts; Evaluation of alternative energy conservation policies; Analyses of regression results; Travel and energy data for conservation policies; Regression analyses using air/auto costs. Portions of this document are not fully legible. Author (GRA)

**N76-29058#** Committee on Government Operations (U. S. Senate).  
**ENERGY ADVISORY COMMITTEES**  
 Washington GPO 1975 406 p refs Hearing before Subcomm. on Reports, Accounting, and Management of Comm. on Govt. Operations, 94th Congr., 1st Sess., 1 Aug. 1975  
 (GPO-59-000) Avail: SOD HC \$3.55

Testimony is presented on the activities of the President's Labor-Management Committee dealing with national energy policies. A total of 75 energy advisory committees are included. Pollution control and protection of the environment are emphasized. J.M.S.

**N76-29695#** Army War Coll., Carlisle Barracks, Pa.  
**ALASKA'S NORTH SLOPE OIL FIELDS: ENERGY ASSET OR DEFENSE LIABILITY**  
 Lewis L. Simpson 2 Oct. 1975 34 p refs  
 (AD-A022366) Avail: NTIS CSCL 21/4

Discovery of an oil bonanza under Alaska's North Slope offers the hope of some relief from dependence on foreign oil sources. At the same time, the vulnerability to hostile action of the oil fields, of the pipeline carrying crude oil to Valdez, and of the tankers shipping oil from Valdez to refineries suggests that reliance on oil from northern Alaska may be an Achilles heel strategically in time of war. The dilemma caused by the juxtaposition of these two factors was examined in this essay. Research was conducted through a review of the current literature. Present estimates of oil reserves under the North Slope lend credence to the belief that Alaskan oil can provide a measure of self-sufficiency in oil reserves to the US. As such, these fields are of major strategic import. Difficulties include the isolation, terrain, and weather features associated with the area and the complexities in transporting supplies and materials to the North Slope and in getting crude oil from the wellheads to refineries. These problems also affect the capability of the US to safeguard the various installations in case of war, but the vital strategic significance of this oil mandates the utmost vigilance in its protection from all sources of attack. Author (GRA)

**N76-29700\*** National Aeronautics and Space Administration. Pasadena Office, Calif.

**HYDROGEN RICH GAS GENERATOR Patent**  
 John Houseman (JPL), Jack H. Rupe (JPL), and Raymond O. Kushida, inventors (to NASA) (JPL) Issued 11 May 1976  
 11 p Filed 10 Feb. 1975 Continuation-in-part of abandoned US Patent Appl. SN-390049, filed 20 Aug. 1973 Sponsored by NASA  
 (NASA-Case-NPO-13342-2; US-Patent-3,955,941;  
 US-Patent-Appl-SN-548559; US-Patent-Class-48-95;  
 US-Patent-Class-23-281; US-Patent-Class-48-215;  
 US-Patent-Class-123-1A; US-Patent-Class-123-3;  
 US-Patent-Class-423-650; US-Patent-Appl-SN-390049) Avail:  
 US Patent Office CSCL 10A

A process and apparatus is described for producing a hydrogen rich gas by injecting air and hydrocarbon fuel at one end of a cylindrically shaped chamber to form a mixture and igniting the mixture to provide hot combustion gases by partial oxidation of the hydrocarbon fuel. The combustion gases move away from the ignition region to another region where water is injected to be turned into steam by the hot combustion gases. The steam which is formed mixes with the hot gases to yield a uniform hot gas whereby a steam reforming reaction with the hydrocarbon fuel takes place to produce a hydrogen rich gas.

Official Gazette of the U.S. Patent Office

**N76-29701\*** National Aeronautics and Space Administration. Pasadena Office, Calif.

**SOLAR-POWERED PUMP Patent**  
 Charles C. Kirsten, inventor (to NASA) (JPL) Issued 3 Aug. 1976 6 p Filed 9 Apr. 1975 Supersedes N75-22746 (13-14, p 1659) Sponsored by NASA  
 (NASA-Case-NPO-13567-1; US-Patent-3,972,651;  
 US-Patent-Appl-SN-566493; US-Patent-Class-417-141;  
 US-Patent-Class-60-517; US-Patent-Class-62-6;  
 US-Patent-Class-417-207; US-Patent-Class-417-379;  
 US-Patent-Class-417-209) Avail: US Patent Office CSCL 10A

A solar powered pump particularly suited for intermittently delivering a stream of water is reported. The pump is characterized by a housing adapted to be seated in a source of water having a water discharge port disposed above the water line of the source, a sump including a valved inlet port through which water is introduced to the sump, disposed beneath the water line, a displacer supported for vertical reciprocation in said housing, an air passageway extended between the vertically spaced faces of the displacer, and a tipple disposed adjacent to the water discharge port adapted to be filled in response to a discharge of water from the housing. Air above a displacer is expanded in response to solar energy impinging on the housing and transferred into pressurizing relation with the sump for forcing water from the sump. Official Gazette of the U.S. Patent Office

**N76-29706#** Brookhaven National Lab., Upton, N.Y. Dept. of Applied Science.

**HYDROGEN PRODUCTION, STORAGE, AND CONVERSION FOR ELECTRIC UTILITY AND TRANSPORTATION APPLICATION**

S. Srinivasan and R. H. Wiswall Oct. 1975 28 p refs Sponsored by ERDA

(BNL-20590) Avail: NTIS HC \$4.00

The energy efficiency for hydrogen production by water electrolysis is about 75%. With improved catalysts, higher operating temperatures and better separator materials in advanced systems (Teledyne, Lurgi, and General Electric water electrolyzers), it should be possible to carry out water electrolysis at close to 100% efficiencies. The storage of hydrogen as a metal hydride shows significant advantages over the cryogenic or compressed gas procedures. For electric utility applications, its feasibility is demonstrated using an iron-titanium alloy. Though this alloy may also be suitable for hydrogen storage in buses and trains, it will be necessary to consider the lighter hydrides for automobiles. With fuel cells or combined cycle gas turbines, it should be possible to attain energy conversion efficiencies of about 60%. The present status and potential for improvements in acid, alkaline, molten carbonate, and solid oxide fuel cell systems are briefly summarized. Author (ERA)

**N76-29707#** McElroy (Ralph) Co., Austin, Tex.

**METHANOL AS A FUEL**

T. Yamamoto [1973] 16 p Transl. into ENGLISH from Sekiyu Gakkaishi (Japan), v. 16, no. 10, 1973 p 825-828 Sponsored by ERDA

(UCRL-Trans-10697) Avail: NTIS HC \$3.50

The significant difference between methanol fuel and hydrocarbon fuel is that the latter has a heating value of 10,000 cal and the former has 5,000 cal, one half of the latter, and the latter has 50-100 cal of latent heat of vaporization and the former has a great latent heat of vaporization of 263 cal. Moreover, methanol is soluble in water and sensitive to various kinds of chemical reaction. These properties are drawbacks as a fuel. However, they are changed into advantages by suitable application and treatment. The following uses for methanol are discussed: (1) source material for hydrogen; (2) fuel for small scale electricity generation by fuel cells; (3) fuel for a boiler which does not produce NO/sub x/; (4) fuel for a non-polluting car; (5) resources for city gas; (6) use for the production of deoxidizing gas in metallurgy; and (7) use for the synthesis of protein from methanol feeding microbes. These usages make use of the special properties of methanol and can display the true value of methanol as a fuel. Author (ERA)

**N76-29708#** Dow Chemical Co., Midland, Mich.

**SOLAR ENERGY SUBSYSTEMS EMPLOYING ISOTHERMAL HEAT STORAGE MATERIALS, PHASE 1 Technical Report, 18 Sep. 1974 - 30 Apr. 1975**

G. A. Lane, D. N. Glew, E. C. Clarke, S. W. Quigley, and H. E. Rossow May 1975 43 p refs Sponsored by ERDA (Contract NSF C-906)

(ERDA-117) Avail: NTIS HC \$4.00

The literature was searched for phase-change solar heat storage candidate materials melting in the range 10 to 90 C. About 200 salts, organic compounds, and eutectic substances were selected initially. These are tabulated in this report. Through the use of DTA and freezing curve data, this group was reduced to approximately 50 candidates, about 20 of which exhibit little or no supercooling. The latter are prime candidates for encapsulation studies. Heat of fusion measurements have been made on most of these 20 materials. Thermal cycling studies have begun, and other tests are under way. Author (ERA)

**N76-29709#** Mobil Tyco Solar Energy Corp., Waltham, Mass. **PHOTOVOLTAIC ENGINEERING SERVICES PERTINENT TO SOLAR ENERGY CONVERSION**

R. O. Bell, J. C. T. Ho, W. Kurth, and T. Surek Jun. 1975 127 p refs

(Contract W-31-109-eng-38)

(ANL-K-75-3171-1) Avail: NTIS HC \$7.00

The application of the compound parabolic concentrator (CPC) for use with solar cells was investigated. Experiments with state-of-the-art Si cells in a CPC and under solar concentration were performed. A theoretical model for calculating the behavior of Si solar cells with concentration was developed. Detailed calculations of the energy distribution in the CPC were made. Finally a cost effectiveness analysis shows that the CPC system will produce power at very much lower cost than will flat panel solar cell arrays. Author

**N76-29712#** Infodyne Systems, Inc., Potomac, Md.

**ECONOMIC IMPACT STUDY OF THE APPLIANCE EFFICIENCY PROGRAM Final Report**

Alexander, Woroniak and John J. Murphy Jun. 1975 282 p refs

(Contract FEA-CO-04-50234-00)

(PB-251665/6; FEA/D-76/077) Avail: NTIS HC \$9.25 CSCI 10A

The economic impact is analyzed of technical improvements that would have to be incorporated into major household appliances to make 1980 models provide the same level of performance as 1972 models, but require twenty per cent less energy to operate. The appliances covered by the efficiency program and their specific energy efficiency goal objectives for 1980 are: room air conditioners; electric and gas water heaters; refrigerators and refrigerator/freezers; freezers; electric and gas ranges; electric and gas dryers; washers; dishwashers; and black and white and color televisions. GRA

**N76-29713#** Electric Power Research Inst., Palo Alto, Calif. **PROCEEDINGS ON FORECASTING METHODOLOGY FOR TIME-OF-DAY AND SEASONAL ELECTRIC UTILITY LOADS**

James W. Boyd, ed. Mar. 1976 272 p refs

(PB-251444/6; EPRI-SR-31) Avail: NTIS HC \$9.00 CSCI 10A

The report presents information on the state of the art of seasonal and time-of-day forecasting and explores new methodologies for handling long run conditional forecasting problems. Topics discussed included model selection, short term forecasting, model identification in peak power demand forecasting, intermediate term forecasting of system loads using Box-Jenkins time series analysis load forecasting methodologies in the electric utility industry, estimation of the residential demand cycle for electricity, recent developments in forecasting techniques and strategy, time series modeling and forecasting, and industrial and commercial rate structures and econometric estimation of the demand for electricity. GRA

**N76-29714#** Electric Power Research Inst., Palo Alto, Calif. **A PRELIMINARY FORECAST OF ENERGY CONSUMPTION THROUGH 1985**

Larry J. Williams Mar. 1976 69 p refs

(PB-251445/3; EPRI-SR-37) Avail: NTIS HC \$4.50 CSCI 10A

An econometric energy demand model for the nation is analyzed and used to produce interval estimates of energy consumption by fuel type for each economic sector. In addition to presenting forecasts, the more important features and major limitations of the model are discussed. GRA

**N76-29716#** Economic Research Service, Washington, D. C. **ENERGY IN US AGRICULTURE: COMPENDIUM OF ENERGY RESEARCH PROJECTS**

Jim Rathwell and Gwendolyn Gales Jan. 1976 187 p

(Contract FEA-GC-04-50057-00)

(PB-247642/2; Conserv-Paper-37A; FEA/D-75/629;

FEA/D-CP-37A) Avail: NTIS HC \$7.50 CSCI 02C

This document, a compendium of energy research in the production sector of U.S. agriculture, presents approximately 1,250 entries of ongoing or recently completed research projects and article abstracts related to fuel requirements and energy conservation practice and technologies. The abstracts presented

focus on three general areas: crop production, livestock production, and state and national energy demand data. The practices and technologies which have been included within the scope are those which can be effectively implemented in U.S. agricultural production either immediately or within the next 5 years. GRA

**N76-2918#** Babcock and Wilcox Co., Barberton, Ohio. Fossil Power Generation Div.

**LOW BTU GAS STUDY Final Report**

Jan. 1976 244 p

(PB-251442/O; CEPRI-265-2-FR) Avail: NTIS HC \$8.00 CSCL 10B

Four utility boilers of different designs and firing each of five low to medium Btu gasified coal fuels were investigated to determine the performance of each as built boiler when firing each of the fuels and what physical changes could be made to each unit to permit operation at or near rated capacity and steam temperatures. General observations are: (1) units studied can use the higher Btu fuels, and in most cases, with few modifications; (2) as fuel heating values decrease below 300 Btu/SCF, required boiler modifications and resulting conversion expenses increase rapidly; (3) variances between the five fuels and the original boiler design fuels effect the resulting flue gas properties that influence boiler heat transfer and distribution; and (4) any boiler considered for conversion should be studied in detail using the specific analysis of the proposed gasified coal fuel. GRA

**N76-29721#** Department of Transportation, Washington, D.C. **REPORT TO CONGRESS ON ENERGY CONSERVATION POLICIES AND PRACTICES BY THE FEDERAL AVIATION ADMINISTRATION Final Report**

Feb. 1976 183 p

(AD-A021312) Avail: NTIS CSCL 21/4

The report is essentially historical in nature and provides a factual presentation of energy policies and practices as required by the Act. These include: Early FAA actions; The FAA's seven-point conservation program and follow-on investigation energy conservation measures; Recent or on-going actions in fuel conservation; and Long-range prospects for energy conservation. GRA

**N76-29727#** National Science Foundation, Washington, D.C. Div. of Advanced Energy Research and Technology.

**METHODS OF DIRECT CONVERSION OF THERMAL ENERGY INTO ELECTRICAL ENERGY**

Jan. 1975 144 p refs, Transl. into ENGLISH from Reports of All-Union Conf. on the Utilization of Solar Energy, Moscow, 17-21 Jun. 1969, section S-6 Sponsored in part by the National Science Foundation

(TT-74-58064) Avail: NTIS HC \$6.00 CSCL 10B

Contents: Solar thermionic energy plants; Experimental photobatteries for sea-navigation-light signalling devices; The solar thermoelectric generator as an autonomous source of feed to water elevating installations; Energy balance of solar water elevating installations equipped with photoconverters; Possible energy and technical characteristics of solar thermoelectric generators with two cascade converters; Low temperature thermoelectric converters of solar energy; The photoelectric pump; Investigation of the efficiency of photobatteries at high illumination and temperatures; Investigating the possibilities of augmenting the power of the photoelectric converters of the solar energy; Optimization of the regime of electric energy generation of the autonomous system of the photoelectric generator-direct current motor; The rational utilization of the solar photo-converters plants for sustaining several consumers; The possibilities of using radiating concentrator for photobatteries; Investigation of radiators for the spreading of heat from the collector-generators of the solar energy. GRA

**N76-29728#** National Science Foundation, Washington, D.C. Div. of Advanced Energy Research and Technology.

**METHODS OF DIRECT CONVERSION OF THERMAL ENERGY INTO ELECTRICAL ENERGY**

Jan. 1975 100 p refs Transl. into ENGLISH of Reports of All-Union Conf. on the Utilization of Solar Energy, Moscow, 17-21 Jun. 1969, section S-5.

(TT-74-58067) Avail: NTIS HC \$5.00 CSCL 10B

Contents: optical coatings and thermal balance of semiconductor converters used in converting the solar energy into electricity; multilayered illuminating coatings for silicon photoelements; selective coatings for collector surfaces of solar thermoelectric generators; selective properties of the polymer coatings for solar energy concentrators; the effect of temperature on the reflector capacity of aluminum layered concentrators; spectral investigation of ground radiation limits on the SF-4 spectrophotometer; a study of the behavior of new silicon organic polymer materials used in solar energy plants; problems of protection of the working surfaces of solar energy plants in the southern regions of the U.S.S.R.; thermophysical and durability characteristics of solar battery materials; investigation of the absorption capability of metals for solar radiations in the temperature range 400-1500 C; the effect of atmospheric optical mass on the coefficients of selectively coated materials; the selection of construction materials for solar distillation systems; experimental setup for investigating the coefficient of thermal E.M.F. and electric conductivity of semiconductor materials by the dynamic method; some results of accelerated tests on helioplants; and new helioplants for accelerated testing of materials. GRA

**N76-29730#** Naval Weapons Center, China Lake, Calif.

**CONVERSION OF SOLID WASTE TO FUELS Final Report, Jul. 1973 - Jul. 1974**

C. B. Benham and J. Diebold Jan. 1976 34 p refs

(ARPA Order 2772)

(AD-A021655; NWC-TR-5797) Avail: NTIS CSCL 13/2

Economic and practical processes for recovering energy from solid waste were studied. Two promising fuels were identified - polymer gasoline and methanol. A nominal 10-pound-per-hour pyrolysis system was constructed and tested. Preliminary cost analyses and studies of the effects of population and energy market value on fuel costs were also conducted. Author (GRA)

**N76-29732#** National Bureau of Standards, Washington, D.C. Inst. for Applied Technology.

**BUILDING ENERGY AUTHORITY AND REGULATIONS SURVEY: STATE ACTIVITY Final Report**

Robert M. Eisenhard Jan. 1976 52 p Sponsored in part by ERDA

(PB-250858/8; NBSIR-76-986) Avail: NTIS HC \$4.50 CSCL 13A

This report provides information on the status of State authority to regulate energy use in new buildings and the status of bills creating such authority that were pending in the 1975 legislative session. Regulations that have been developed are identified and described. Legislation relating to solar energy, retrofitting, insulation and other building energy matters, is identified and the status indicated. GRA

**N76-29734#** Informatics, Inc., Rockville, Md.

**GEOHERMAL ENERGY Scientific Interim**

Vlastimir A. Stevovich 15 Nov. 1975 531 p refs

(Contract MDA903-76-C-0099; DARPA Order 3097)

(AD-A022054) Avail: NTIS CSCL 08/7

This is a comprehensive review of present major developments and future planning in various fields of applied geothermal engineering. The study covers theoretical and experimental data on the background and state-of-the-art of applied geothermal research in general, with emphasis on foreign work. GRA

**N76-29736#** Tetra Tech, Inc., Arlington, Va.

**SUMMARY OF NATO SYNTHETIC FUEL ALTERNATIVES**

Glen Tomlinson 27 Jan. 1975 31 p refs

(Contract N00014-74-C-0348)

(AD-A022081; TETRAT-A-642-75-158) Avail: NTIS CSCL 21/4

In the past year, the problem of natural crude supply (and its cost) has reached critical proportions for the United States and Western Europe. In view of this crisis the NATO countries

have been forced to consider such alternative fossil fuel sources as coal, oil shale, and tar sands for their military forces. The use of these fuels does not present a problem of supply, for the NATO nations have deposits of these fossil fuels that far exceed the proven world reserves of crude oil. It does, however, present a problem of technology - how to realize and use effectively the synthetic product of these deposits. Coal, for example, is particularly plentiful, exceeding the NATO oil reserves and oil shale and tar sands resources by almost a factor of ten. NATO naval forces are affected by the fuel shortage and cost since most NATO naval ships and all its aircraft use liquid hydrocarbon fuels; the requirement for large quantities of liquid fossil fuels will continue for at least the next 25 years. Consequently, the military forces of NATO are particularly interested in the development of other sources and production methods for liquid fossil fuels. Conversion technologies for producing liquid fuel products from oil shale and coal have been demonstrated, a commercial tar sands plant is currently in operation in Canada, and several research and development programs are being conducted to improve the conversion process and to reduce the cost of synthetic fuels. The improved oil shale and coal conversion processes are now entering the pilot plant stage; commercial oil shale plants are expected to begin operation by 1980 and commercial coal liquefaction plants should begin operation by 1985. GRA

**N76-29756#** Radian Corp., Austin, Tex.  
**ELECTRICAL ENERGY AS AN ALTERNATE TO CLEAN FUELS FOR STATIONARY SOURCES. VOLUME 2: APPENDIX** Final Report, Jun. 1974 - Oct. 1975  
 R. M. Wells and W. E. Corbett Mar. 1976 476 p refs 2 Vol.  
 (Contract EPA-68-02-1319)  
 (PB-251830/6; EPA-600/2-76-049b-Vol-2) Avail: NTIS HC \$12.50 CSCL 081

The energy consumed by the metal, chemical, petroleum, food, paper, and glass industries is summarized along with the technology and environmental impacts associated with coal mining, oil shale mining, gas recovery, coal cleaning, coal gasification and liquefaction, petroleum refining, steam electric power generation, and rail and pipeline transportation.

Author (GRA)

**N76-30105#** California Univ., Davis. Institute of Ecology.  
**LAND USE, ENERGY FLOW, AND POLICY MAKING IN SOCIETY** Final Report  
 J. W. Young, J. L. Mitchiner, K. E. F. Watt, C. Ayers, and J. W. Brewer 1 Sep. 1975 394 p refs  
 (Grant NSF G1-27)  
 (PB-251537/7; NSF/RA/E-75-048) Avail: NTIS \$10.75 CSCL 13B

Interpretations of cause and effect are referred to as 'models', and data extrapolations are referred to as 'simulations', although such terminology is unconventional. The purpose is twofold: first, to provide a methodology for improving computer aids to modeling and to simulation; second, to apply the modeling methodology to the simulation of the use of land and energy in society. The computer aids are specifically designed for the evaluation of policy for land and energy use and not for decision making needed to implement policy. The abstract view of simulation and modeling presented here may initially be difficult to accept. It is, however, useful to conceive of 'understanding of need' as a hypothetical set of cause and effect relationships (models). It is similarly useful to view 'simulation' as a process of extrapolation. GRA

**N76-30390#** Institute of Gas Technology, Chicago, Ill.  
**ALTERNATIVE FUELS FOR AUTOMOTIVE TRANSPORTATION: A FEASIBILITY STUDY. VOLUME 1: EXECUTIVE SUMMARY**  
 J. Pangborn and J. Gillis Jul. 1974 33 p refs 3 Vol.  
 (Contract EPA-68-01-2111)  
 (EPA-460/3-74-012a-Vol-1) Avail: NTIS HC \$4.75

Potentially feasible alternative fuels are assessed for their economic and technical practicality and the most promising fuels are recommended for three specific time frames. A model for energy supply and demand by market sectors was devised, and cost estimates were made. It was concluded that alternative automotive fuels from domestic sources can alleviate petroleum imports. Coal, oil shale, and fissionable nuclear fuels are adequate resources, while the preferred fuels are gasoline and hydrocarbon distillates, methanol, and hydrogen. An executive summary of this study is presented. ERA

**N76-30391#** Institute of Gas Technology, Chicago, Ill.  
**ALTERNATIVE FUELS FOR AUTOMOTIVE TRANSPORTATION: A FEASIBILITY STUDY. VOLUME 2: TECHNICAL SECTION**

J. Pangborn and J. Gillis Jul. 1974 283 p refs 3 Vol.  
 (Contract EPA-68-01-2111)  
 (EPA-460/3-74-012b-Vol-2) Avail: NTIS HC \$15.00

The technical details of a study to find suitable non-petroleum-based fuels which are available on the long term from domestic sources are presented. Factors considered include: (1) energy demand and supply; (2) fuel availability; (3) fuel synthesis technology; and (4) the physical, chemical, and combustion properties of the fuels. ERA

**N76-30392#** Institute of Gas Technology, Chicago, Ill.  
**ALTERNATIVE FUELS FOR AUTOMOTIVE TRANSPORTATION: A FEASIBILITY STUDY. VOLUME 3: APPENDICES**

J. Pangborn and J. Gillis Jul. 1974 114 p refs 3 Vol.  
 (Contract EPA-68-01-2111)  
 (EPA-460/3-74-012c-Vol-3-App) Avail: NTIS HC \$8.75

Various data collected in a study of domestic, non-petroleum based automotive fuels are presented in two appendices: properties of potential alternative fuels for automotive transportation; and detailed process descriptions and economics for candidate fuels from coal and oil shale. The combustion characteristics, the overall energy balance and efficiency, the pollution problems, and an economic analysis are presented for each of the candidate fuels from coal and oil shale. ERA

**N76-30640#** Federal Energy Administration, Washington, D.C.  
 Office of Coal and Electric Power Analysis.  
**US COAL RESOURCES AND RESERVES**  
 N. A. Parker and B. C. Thompson May 1976 16 p refs  
 (PB-252752/1; FEA/B-76/210) Avail: NTIS HC \$3.50 CSCL 08G

This report is made up of three sections: The first defines the different categories of coal resources and provides estimates of the extent of each. The second discusses the sulfur content of coal in relation to environmental standards, and the third presents data on coal reserves on Federal and Indian lands, where a major portion of the Nation's reserves are located. GRA

**N76-30643#** Utah Water Research Lab., Logan.  
**WATER AS A FACTOR IN ENERGY RESOURCES DEVELOPMENT**

A. Bruce Bishop, Melvin D. Chambers, and William O. Mace Jun. 1975 114 p refs  
 (Contract DI-14-31-0001-5045; OWRT Proj. A-028-UTAH(1))  
 (PB-250750/7; PRJER028-1; W76-05250) Avail: NTIS HC \$5.50 CSCL 13B

Particularly where water supplies are short and water quality degradation is a critical consideration, the water resource system conflicts associated with energy development at alternative sites need to be carefully examined. To demonstrate the model structure and capabilities, an application is made to the energy resources region within the Utah portion of the Colorado River Basin. Surface water resources available by stream reaches are designated, and the possible energy developments requiring water inputs, for both extraction and conversion processes, are located. For the initial application of the model, optimal solutions were obtained for both energy maximization and water minimization which illustrate composite system effects and potential conflicts that could arise from various combinations of water allocation to energy resources developments. GRA

**N76-30653\*#** AiResearch Mfg. Co., Los Angeles, Calif.  
**DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR  
 CONDITIONER: ECONOMIC ANALYSIS**

28 Mar. 1975 16 p ref  
 (Contract NAS8-30758)  
 (NASA-CR-149976; AiResearch-74-10996(4)) Avail: NTIS  
 HC \$3.50 CSCL 10A

The results of investigations aimed at the development of cost models to be used in the economic assessment of Rankine-powered air conditioning systems for residential application are summarized. The rationale used in the development of the cost model was to: (1) collect cost data on complete systems and on the major equipment used in these systems; (2) reduce these data and establish relationships between cost and other engineering parameters such as weight, size, power level, etc; and (3) derive simple correlations from which cost-to-the-user can be calculated from performance requirements. The equipment considered in the survey included heat exchangers, fans, motors, and turbocompressors. This kind of hardware represents more than 2/3 of the total cost of conventional air conditioners. Author

**N76-30654\*#** AiResearch Mfg. Co., Los Angeles, Calif.  
**DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR  
 CONDITIONER: DESIGN REQUIREMENTS AND TRADE-  
 OFF PARAMETERS**

22 Nov. 1974 12 p refs  
 (Contract NAS8-30758)  
 (NASA-CR-149971; AiResearch-74-10996(2)) Avail: NTIS  
 HC \$3.50 CSCL 10A

Data basic to the design, characterization, comparison, and evaluation of solar-powered residential air conditioner concepts are presented. Author

**N76-30655\*#** AiResearch Mfg. Co., Los Angeles, Calif.  
**DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR  
 CONDITIONER. PROGRAM REVIEW**

8 Apr. 1975 65 p refs  
 (Contract NAS8-30758)  
 (NASA-CR-149973; AiResearch-74-10996(5)) Avail: NTIS  
 HC \$4.50 CSCL 10A

Progress in the effort to develop a residential solar-powered air conditioning system is reported. The topics covered include the objectives, scope and status of the program. The results of state-of-art, design, and economic studies and component and system data are also presented. Author

**N76-30656\*#** AiResearch Mfg. Co., Los Angeles, Calif.  
**DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR  
 CONDITIONER**

13 Jan. 1975 36 p refs  
 (Contract NAS8-30758)  
 (NASA-CR-149972; AiResearch-74-10996(3)) Avail: NTIS  
 HC \$4.00 CSCL 10A

An extensive review of the literature was conducted which was concerned with the characterization of systems and equipment that could be applicable to the development of solar-powered air conditioners based on the Rankine cycle approach, and the establishment of baseline data defining the performance, physical characteristics, and cost of systems using the LiBr/H<sub>2</sub>O absorption cycle. Author

**N76-30657\*#** National Aeronautics and Space Administration,  
 Goddard Space Flight Center, Greenbelt, Md.  
**RESULTS FROM THE IMP-J VIOLET SOLAR CELL EXPERI-  
 MENT AND VIOLET CELL BALLOON FLIGHTS**

Edward M. Gaddy Feb. 1976 11 p refs  
 (NASA-TM-X-71168; X-711-76-29) Avail: NTIS HC \$3.50  
 CSCL 10A

The IMP-J violet solar cell experiment was flown in an orbit with mild thermal cycling and low hard particle radiation. The results of the experiment show that violet cells degrade at about the same rate as conventional cells in such an orbit. Balloon flight measurements show that violet solar cells produce approximately 20% more power than conventional cells. Author

**N76-30658#** Committee on Government Operations (U. S.  
 House).

**CONSERVATION AND EFFICIENT USE OF ENERGY**

Washington GPO 1974 137 p refs Rept. for Comm. on  
 Govt. Operations, 93d Congr., 2d Sess., 18 Dec. 1974  
 (H-Rept-93-1635; Rept-26) Avail: US Capitol, House Document  
 Room

The potential for energy conservation in the industrial, transportation, residential, and commercial sectors is discussed. The economics of energy supply and consumption are analyzed. Recommendations for the facilitation of energy conservation are presented, and various areas of energy research are discussed. Environmental factors are also considered. D.M.L.

**N76-30659\*#** AiResearch Mfg. Co., Los Angeles, Calif.  
**DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR  
 CONDITIONER: SCREENING ANALYSIS**

25 Jul. 1975 67 p refs  
 (Contract NAS8-30758)  
 (NASA-CR-149974; AiResearch-74-10996(7)) Avail: NTIS  
 HC \$4.50 CSCL 10A

Screening analysis aimed at the definition of an optimum configuration of a Rankine cycle solar-powered air conditioner designed for residential application were conducted. Initial studies revealed that system performance and cost were extremely sensitive to condensing temperature and to the type of condenser used in the system. Consequently, the screening analyses were concerned with the generation of parametric design data for different condenser approaches; i. e., (1) an ambient air condenser, (2) a humidified ambient air condenser (3) an evaporative condenser, and (4) a water condenser (with a cooling tower). All systems feature a high performance turbocompressor and a single refrigerant (R-11) for the power and refrigeration loops. Data were obtained by computerized methods developed to permit system characterization over a broad range of operating and design conditions. The criteria used for comparison of the candidate system approaches were (1) overall system COP (refrigeration effect/solar heat input), (2) auxiliary electric power for fans and pumps, and (3) system installed cost or cost to the user. Author

**N76-30660\*#** AiResearch Mfg. Co., Los Angeles, Calif.  
**DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR  
 CONDITIONER: SYSTEM OPTIMIZATION PRELIMINARY  
 SPECIFICATION**

J. Rousseau and K. C. Hwang 7 Nov. 1975 134 p  
 (Contract NAS8-30758)  
 (NASA-CR-149975; AiResearch-74-10996(8)) Avail: NTIS  
 HC \$6.00 CSCL 10A

Investigations aimed at the optimization of a baseline Rankine cycle solar powered air conditioner and the development of a preliminary system specification were conducted. Efforts encompassed the following: (1) investigations of the use of recuperators/regenerators to enhance the performance of the baseline system, (2) development of an off-design computer program for system performance prediction, (3) optimization of the turbocompressor design to cover a broad range of conditions and permit operation at low heat source water temperatures, (4) generation of parametric data describing system performance (COP and capacity), (5) development and evaluation of candidate system augmentation concepts and selection of the optimum approach, (6) generation of auxiliary power requirement data, (7) development of a complete solar collector-thermal storage-air conditioner computer program, (8) evaluation of the baseline Rankine air conditioner over a five day period simulating the NASA solar house operation, and (9) evaluation of the air conditioner as a heat pump. Author

**N76-30661#** Atomic Energy of Canada Ltd., Pinawa (Manitoba).  
**NUCLEAR POWER FOR DISTRICT HEATING**

R. B. Lyon and R. O. Sochaski Sep. 1975 70 p refs  
 (AECL-5117) Avail: ERDA Depository Libraries HC \$4.50  
 Scientific Document Distribution Office, Atomic Energy of Canada  
 Limited, Chalk River, Ontario HC \$1.50

Current district heating trends are towards an increasing use of electricity. The evaluation of an alternative means of energy

supply, the direct use of thermal energy from CANDU nuclear stations, is described. The energy would be transmitted via a hot fluid in a pipeline over distances of up to 40 km. Advantages of this approach include a high utilization of primary energy, with a consequent reduction in installed capacity, and load flattening due to inherent energy storage capacity and transport delays. Disadvantages include the low load factors for district heating, the high cost of the distribution systems and the necessity for large-scale operation for economic viability. This requirement for large-scale operation from the beginning could cause difficulty in the implementation of the first system. Various approaches have been analyzed and costed for a specific application -- the supply of energy to a district heating load centre in Toronto from the location of the Pickering reactor station about 40 km away. Author (NSA)

**N76-30664#** Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany).

**APPROACH TOWARD DETERMINING AND ASSESSING EFFECTS OF INNOVATIONS IN ENERGY SUPPLY BY MEANS OF A COMBINED ENERGY AND ECONOMY MODEL**

R. Buende May 1975 79 p refs In GERMAN; ENGLISH summary (IPP-4/132) Avail: ERDA Depository Libraries HC \$5.00

The energy system is represented as part of a national economy and analyzed by means of the input - output technique. The development of a mathematical model based on two existing models using the same technique is described. This will allow the time behavior of the energy system and the total system to be simulated and optimized for different objective functions and constraints. In addition, consequences of impacts on the system, e.g., the development of a new energy source such as the fusion reactor, can be shown. Author (ERA)

**N76-30669#** Development Sciences, Inc., East Sandwich, Mass. **A STUDY TO DEVELOP ENERGY ESTIMATES OF MERIT FOR SELECTED FUEL TECHNOLOGIES** Final Report

Alton J. Frabetti, Charles N. Flinkstrom, Morton Gorden, Russel A. Lovell, Jr., Charles Sheldon, II, James D. Westfield, and Peter F. Way 23 Sep. 1975 385 p refs (Contract DI-14-01-0001-2141)

(PB-249994/5; DSI-038) Avail: NTIS HC \$10.75 CSCL 10A This study calculates the true energy costs to society associated with the delivery of a given amount of usable energy (1000 Btu) by various energy supply systems. Included as part of the energy costs were the direct process energy requirements and also the indirect costs associated with the production of the plant operating supplies and (amortized) capital equipment.

GRA

**N76-30670#** Electric Power Research Inst., Palo Alto, Calif. **NUCLEAR POWER, COAL, AND ENERGY CONSERVATION Special Report No. 34**

P. L. Auer, A. S. Manne, and O. S. Yu Mar. 1976 35 p refs (PB-251262/2; EPRI-SR-34) Avail: NTIS HC \$4.00 CSCL 10A

A programming model is used to explore options by which the U.S. may realistically move from its dependence on oil and gas to a more diversified energy economy based on nuclear power and/or coal. Supply options considered are: direct combustion of coal; conversion of coal to synthetic fuels; petroleum, natural gas, and oil shale resources; nuclear energy from light water and fast breeder reactors; hydrogen via electrolysis; solar power; and fusion. GRA

**N76-30671#** Federal Power Commission, Washington, D.C. Bureau of Natural Gas.

**THE GAS SUPPLIES OF INTERSTATE NATURAL GAS PIPELINE COMPANIES - 1974**

Mar. 1976 126 p (PB-251256/4) Avail: NTIS HC \$6.00 CSCL 21D

Contents: Total interstate gas supply; summary, domestic gas supply trends interstate pipeline companies; imports and exports, regional distribution of domestic gas reserves by FPC

gas areas and by state; domestic gas reserves, major gas supply companies; total gas supply composition by company; deliverability. GRA

**N76-30673#** National Bureau of Standards, Washington, D.C. Office of Energy Conservation.

**ENERGY CONSERVATION PROGRAM GUIDE FOR INDUSTRY AND COMMERCE (EPIC). SUPPLEMENT 1 Final Report**

Robert G. Massey, ed. Dec. 1975 95 p Sponsored in part by FEA, Washington, D. C., Office of Energy Conservation and Environment (PB-250855/4; NBS-HB-115-Suppl-1; LC-74-600153) Avail: NTIS HC \$5.00 CSCL 10A

The Energy Conservation Program Guide for Industry and Commerce is a handbook to assist business firms to establish an on-going conservation program. This supplement contains simplified management program, additional conservation opportunities, case studies, and sources of information. GRA

**N76-30675#** Utah State Univ., Logan.

**THE MARKET CAPTURE POTENTIAL OF SINGLE VERSUS MULTI-STRUCTURE SOLAR ENERGY SPACE CONDITIONING SYSTEMS: 1975 - 2010**

H. Craig Petersen Jan. 1976 87 p refs

(Grant NSF AER-74-09043-A01) (PB-252451/0; NSF/RA-760024) Avail: NTIS HC \$5.00 CSCL 13A

One of the main problems with solar energy space conditioning and water heating systems is that systems mounted on individual structures require a certain type of roof orientation and tilt, and are usually not economically-viable for retrofitting of existing structures. If solar energy systems could be ground-mounted and serve small groups of structures, then these constraints might be eliminated. This report considers the implications of ground-mounted, multi-structure systems. It considers the relative cost of single vs. multi-structure systems and how much the rate of solar energy use can be accelerated if multi-structure systems are made available. GRA

**N76-30677#** Virginia Univ., Charlottesville.

**PROCEEDINGS OF THE WORKSHOP ON SOLAR ENERGY STORAGE SUBSYSTEMS FOR THE HEATING AND COOLING OF BUILDINGS**

Lembit U. Lilleleht, J. Taylor Beard, and F. Anthony Iachetta 18 Apr. 1975 191 p refs Workshop held at Charlottesville, Va., 16-18 Apr. 1975 Sponsored by the Am. Soc. of Heating, Refrigerating and Air Conditioning Engineers, Inc., N. Y. (Grant NSF AER-75-06713)

(PB-252449/4; NSF/RA/N-75-041) Avail: NTIS HC \$7.50 CSCL 13A

The current status of the thermal energy storage field, particularly as it relates to energy storage subsystems in buildings is reviewed. Topics ranged from the sensible heat storage in water to latent heat storage in chemical bonds; from use of hot water tanks to building heat capacity to long term storage in ice houses and aquifers. GRA

**N76-30681#** Teknekron, Inc., Berkeley, Calif.

**A TECHNICAL AND ECONOMIC STUDY OF WASTE OIL RECOVERY. PART 4: ENERGY CONSUMPTION IN WASTE OIL RECOVERY. PART 5: A FIELD TEST OF THE QUALITY OF RE-REFINED LUBE OILS. PART 6: A REVIEW OF RE-REFINING ECONOMICS** Final Report

Peter M. Cukor and Timothy Hall Oct. 1975 141 p refs (Contract EPA-68-01-2904)

(PB-251716/7; EPA-530/SW-90c.4-Pt.4; EPA-530/SW-90c.4-Pt.5; EPA-530/SW-90c.4-Pt.6) Avail: NTIS HC \$6.00 CSCL 11H

This report contains the following studies: An energy balance of waste oil recycling as lube oil and waste oil recovery as fuel oil; a description of a potential field test re-refined lube oil using motor vehicles on a federal facility; and an update of re-refining economics reflecting increased prices of petroleum products (1974-75). GRA

**N76-31079\*#** United Air Lines, Inc., San Francisco, Calif.  
**STUDY OF COST/BENEFIT TRADEOFFS FOR REDUCING THE ENERGY CONSUMPTION OF THE COMMERCIAL AIR TRANSPORTATION SYSTEM.**

Richard E. Coykendall, John K. Curry, Albert E. Domke, and Sven E. Madsen Jun. 1976 194 p refs  
 (Contract NAS2-8625)

(NASA-CR-137891) Avail: NTIS HC \$7.50 CSCL 05C

Economic studies were conducted for three general fuel conserving options: (1) improving fuel consumption characteristics of existing aircraft via retrofit modifications; (2) introducing fuel efficient derivations of existing production aircraft and/or introducing fuel efficient, current state-of-the-art new aircraft; and (3) introducing an advanced state-of-the-art turboprop airplane. These studies were designed to produce an optimum airline fleet mix for the years 1980, 1985 and 1990. The fleet selected accommodated a normal growth market by introducing somewhat larger aircraft while solving for maximum departure frequencies and a minimum load factor corresponding to a 15% investment hurdle rate. Fuel burnt per available-seat-mile flown would drop 22% from 1980 to 1990 due to the use of more fuel efficient aircraft designs, larger average aircraft size, and increased seating density. An inflight survey was taken to determine air traveler attitudes towards a new generation of advanced turboprops. Author

**N76-31658#** Bureau of Mines, Anchorage, Alaska. Field Operation Center.

**GEOTHERMAL ENERGY: ECONOMIC POTENTIAL OF THREE SITES IN ALASKA** Information Circular, 1975

Jimmie C. Rosenbruch and Robert G. Bottge Dec. 1975 47 p refs

(PB-249878/0; BM-IC-8692) Avail: NTIS HC \$4.00 CSCL 08I

The prospects for using geothermal energy to generate electricity for mines in remote areas of Alaska are evaluated. Given the development of a geothermal resource for one purpose, the subsidiary uses of space heating and agriculture are examined to see if other industries might be viable given a cheap source of heat energy. Sites investigated are located in three areas of the state: Kobuk in the northwest, Unalaska in the southwest, and Stikine River in the southeast. Each site is relatively close to mineral deposits whose prospects for development would be enhanced with cheap power. GRA

**N76-31659#** Pennsylvania State Univ., University Park.  
**ECONOMIC ANALYSIS OF COAL SUPPLY: AN ASSESSMENT OF EXISTING STUDIES, VOLUME 1** Final Report

Richard L. Gordon Feb. 1976 152 p refs Sponsored by Electric Power Res. Inst.

(PB-249619/8; EPRI-335-1-Vol-1) Avail: NTIS HC\$6.75 CSCL 08I

A partial listing of contents includes: Long run mineral supply--The case of coal in the United States; Systems studies of coal production; Environmental regulation and the allocation of coal; Regional analysis of the U.S. Electric Power Industry; Economic comparison of base load generation alternatives for New England Electric; Energy supply/demand alternatives for the Appalachian Region; An analysis of constraints on increased coal production; Analysis of steam coal sales and purchases; Energy alternatives; Economic and technological analysis of initiatives and innovations to secure fuel supply independence; processes, procedures, and methods to control pollution from mining activities. Author (GRA)

**N76-31667\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**THERMAL ENERGY STORAGE SYSTEM** Patent

Lott W. Brantley, Jr., inventor (to NASA) Issued 31 Aug. 1976 5 p Filed 7 Aug. 1975 Supersedes N75-29547 (13 - 20, p 2541)

(NASA-Case-MFS-23167-1; US-Patent-3,977,197;

US-Patent-Appl-SN-602618; US-Patent-Class-60-659;

US-Patent-Class-165-10) Avail: US Patent Office CSCL 10C

A thermal energy storage system is described for converting a fluid such as water into a superheated vapor for driving a turbine and it also includes an energy storage device for storing thermal energy from the vapor to be utilized should the pressure of the vapor fall below a predetermined value. The energy storage device includes a storage tank having a plurality of stacked vertical compartments containing metallic spheres filled with metal alloy for storing the thermal energy therein and a fluid reservoir below the stacked compartments. Diagrams of the system are shown. Official Gazette of the U.S. Patent Office

**N76-31668** Catholic Univ. of America, Washington, D.C.

**APPLICATION OF THE THERMODYELECTRIC EFFECT TO THE CONVERSION OF SOLAR TO ELECTRICAL ENERGY** Ph.D. Thesis

Francisco Javier Garcia 1976 139 p

Avail: Univ. Microfilms Order No. 76-19369

A description of thermoelectric energy conversion and its limitations is presented, and the thermoelectric conversion cycle is classified as a coupled even-class converter. When the limitations of the cycle are taken into consideration the efficiency of the cycle is found to have a maximum at a given temperature difference. Theoretical expressions for the already known cycle and a new maximum field cycle are presented. Results indicate that ferroelectric materials produce efficiencies too low to be considered in a practical converter application. However, experimental tests show that a thermoelectric polymer, polyvinylidene fluoride, is well suited for this type of conversion. Efficiencies considerably higher than previously reported were measured. Better quality materials could produce even higher efficiencies, which, according to available data, would be in the order of at least 5%. Dissert. Abstr.

**N76-31672#** Committee on Interior and Insular Affairs (U. S. Senate).

**THE 94TH CONGRESS AND THE ENERGY RECORD**

Washington GPO 1976 78 p refs Rept. pursuant to S. Res. 45 for Comm. on Interior and Insular Affairs, 94th Congr., 2d Sess., 1976 Prepared by Library of Congr.

(GPO-67-716) Avail: Comm. on Interior and Insular Affairs

Congressional measures to encourage the conservation of energy and the development of new energy sources are reviewed. Petroleum and its products, coal, natural gas, nuclear energy and solar energy are included. D.M.L.

**N76-31678#** Brookhaven National Lab., Upton, N.Y.

**PERSPECTIVE ON THE ENERGY FUTURE OF THE NORTH-EAST: ENERGY CONSERVATION SCENARIOS FOR THE NORTHEAST UNITED STATES**

M. Marmor Sep. 1975 41 p refs Sponsored by ERDA

(BNL-20783) Avail: NTIS HC \$4.00

Measures were studied for energy conservation in the northeast United States for three scenarios: a base case, moderate, and severe conservation scenarios--corresponding to three levels of implementation of each of the conservation measures. The residential, commercial, and transportation sectors are reported. A largely technological view of energy conservation for purposes of assessing what is possible is presented. The next step is to examine the various policy options available to bring about technological changes that are found to be attractive in this analysis. The range of conservation measures that should be considered for application in the northeast is established by first summarizing the literature on energy conservation at the national level. From a survey of the measures considered in these studies, a set of measures for possible implementation in the Northeast is chosen. Author.(ERA)

**N76-31679#** Argonne National Lab., Ill.

**BATTERY RESEARCH SPONSORED BY THE US ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**

A. A. Landgrebe and P. A. Nelson 1976 12 p refs Presented at Symp. on US Lithium Resources and Requirements by the Year 2000, Lakewood, Colo.: 22 Jan. 1976

(Contract W-31-109-eng-38)

(CONF-760112-1) Avail: NTIS HC \$3.50



A presentation on battery research is given. The development of lithium-aluminum/iron sulfide batteries for the purpose of load-leveling on electric utilities, automotive propulsion and application to new generating systems is discussed. Present programs on developing these batteries and the justification for the programs are described. L.S.

**N76-31689#** Battelle Pacific Northwest Labs., Richland, Wash.  
**ENERGY PROBLEMS AND POTENTIAL SOLUTIONS**  
L. C. Schmid 16 Oct. 1975 13 p  
(Contract E(45-1)-1830)  
(BNWL-SA-5622) Avail: NTIS HC \$3.50

The past and future trends in energy use show a greater growth rate for oil and gas relative to other resources, and reserves of these resources are not being found as rapidly as they are being removed from the ground, resulting in greater dependence of imported Eastern oil. This has resulted in a trade imbalance. These factors are resulting in some current shortages of energy, especially electrical power and natural gas; increasing energy costs; a growing dependence on foreign supplies of fuel; and increased consideration of the social and environmental aspects of energy production, as well as technical and economic ones. In the short and intermediate term, logical solutions based on the energy scenario are to reduce energy demand through conservation; to move away from using scarce resources such as oil and gas which now provide approximately 78% of U. S. energy; to move toward the use of more abundant resources such as coal and uranium; and to develop domestic supplies of oil and gas. In the longer term, renewable sources such as solar, fusion, and geothermal need to be developed. ERA

**N76-31696#** Boston Univ., Mass.  
**PHOTOCHEMICAL CONVERSION OF SOLAR ENERGY**  
**Quarterly Progress Report, 1 Jan. - 31 Mar. 1975**  
Norman N. Lichtin 9 May 1975 17 p refs.  
(Grant NSF AER-72-03597-A03)  
(PB-252962/6; NSF/RA/N-75-250;  
NSF/RANN/SE/AER72-03597-75-1) Avail: NTIS HC \$3.50  
CSCL 07E

Reverse-bias experiments with the iron-thionine thin layer-totally illuminated photogalvanic cell with SnO<sub>2</sub> and Pt electrodes (Ti-TL SnO<sub>2</sub>/Pt cell) indicated that output is not limited by electrode activation-processes. In solutions acidified with H<sub>2</sub>SO<sub>4</sub>, Fe(II) reduces triplet methylene blue 12 times faster in 50 v/v percent aq. CH<sub>3</sub>CN than in water while the rate of unimolecular decay of the triplet is unaffected by the change in solvent. Reduction of the triplet by Fe(II) is four times faster when sulfate is the only anion in solution than in the presence of TFMS(-). Oxidation of methylene blue semiquinone by Fe(III) is six times slower in acidified 50 v/v percent aq. CH<sub>3</sub>CN than in acidified water. Output of the Ti-TL SnO<sub>2</sub>/Pt iron-thionine cell is greater with sulfuric acid than other acids. Significant outputs were obtained when Co-(II) EDTA/Co (III) EDTA or hydroquinone/quinone were substituted for Fe(II)/Fe(III) in the Ti-TL SnO<sub>2</sub>/Pt cell. GRA

**N76-31697#** Stanford Research Inst., Menlo Park, Calif.  
**ENERGY DEVELOPMENT: THE ENVIRONMENTAL TRADE-OFFS. VOLUME 1: SUMMARY OF VOLUMES 2-4** Energy and Environment Series  
Nov. 1975 29 p  
(Contract EPA-68-01-2469)  
(PB-250000/7) Avail: NTIS HC \$4.00; HC also available in set of 4 reports as PB-249999-set, HC \$18.00 CSCL 13B

This volume provides a brief summary of volumes 2 through 4 of the series. The background papers include: technical overview; social impacts of energy development in a rural area; a case example of western coal development; water availability and consumption for energy; water pollution potential of energy conversion processes; and air pollution impacts of energy processes. GRA

**N76-31698#** Stanford Research Inst., Menlo Park, Calif.  
**ENERGY DEVELOPMENT: THE ENVIRONMENTAL TRADE-OFFS. VOLUME 3: RELATIVE ENVIRONMENTAL RANKING OF PROPOSED OFFSHORE CONTINENTAL SHELF AREAS ON THE BASIS OF IMPACTS OF OIL SPILLS** Energy and Environment Series

Patrick J. Kinney, Phillip D. Carpenter, Mark D. Levine, and Steven H. Traver Sep. 1975 71 p refs  
(Contract EPA-68-01-2469)  
(PB-250002/3) Avail: NTIS HC \$4.50; HC also available in set of 4 reports as PB-249999-set, HC \$18.00 CSCL 13B

Environmental impacts resulting from offshore oil development are considered for phytoplankton, zooplankton, benthic biota, fish, marine mammals, and birds. Shore-related effects are also covered. The relative probability of oil spills occurring because of earthquakes, tsunamis, and severe storms is discussed. GRA

**N76-31699#** Stanford Research Inst., Menlo Park, Calif.  
**ENERGY DEVELOPMENT: THE ENVIRONMENTAL TRADE-OFFS. VOLUME 4: BACKGROUND PAPERS** Energy and Environment Series

Mark D. Levine, Robert V. Steele, and Irving W. Yabroff Oct. 1975 132 p refs  
(Contract EPA-68-01-2469; SRI Proj. 3563)  
(PB-250003/1) Avail: NTIS HC \$6.00 CSCL 13B

Background information directly relevant to the analysis of environmental tradeoffs among the different measures to increase U.S. energy supply is presented. Subject areas covered include: Technological Overview; Social Impacts of Energy Development in a Rural Area: A Case Example of Western Coal Development; Water Availability and Consumption for Energy; Water Pollution Potential of Energy Conversion Processes; and Air Pollution Impacts of Energy Processes. GRA

**N76-31700#** Office of Technology Assessment, Washington, D.C.

**ENERGY, THE ECONOMY AND MASS TRANSIT**  
Dec. 1975 155 p refs Prepared in cooperation with Skidmore, Owings and Merrill, Washington, D. C., and System Design Concepts, Inc., Washington, D. C.  
(PB-250624/4; OTA-T-15) Avail: NTIS \$6.75 CSCL 13B

The report examines: (1) the probable effects of changes in energy supplies and prices on transit patronage and the transit industry; (2) the potential role of public mass transit programs in stimulating a depressed economy; and (3) the effect on the economy and on urban transit if transit funds were sharply reduced. The study also evaluates alternative transportation policies for responding to various economic and energy conditions and examines within this framework the effect of transit incentives and automobile disincentives on transit patronage and automobile use. This assessment was performed in response to a request from the Committee on Appropriations, U.S. Senate. GRA

**N76-31701#** Federal Energy Administration, Washington, D.C.  
**ENERGY INFORMATION REPORT TO CONGRESS REQUIRED BY PUBLIC LAW 93-319, AMENDED BY PUBLIC LAW 94-163. THIRD QUARTER 1975**

1975 138 p ref Sponsored by National Energy Information Center, Washington, D. C.  
(PB-242760-03; FEA/B-75/693; QR-3) Avail: NTIS HC \$10.00; HC also available on subscription \$35.00/year domestic, \$45.00/year foreign CSCL 10A

Resource development, coal, natural gas, crude oil, refined petroleum products, nuclear energy, and electric power are discussed. Topic areas cover such things as production, consumption, imports, exports, and reserves. GRA

**N76-31702#** Delaware Univ., Newark. Inst. of Energy Conversion.

**DIRECT SOLAR ENERGY CONVERSION FOR LARGE SCALE TERRESTRIAL USE** Quarterly Progress Report, 1 Jan. - 31 Mar. 1975

K. W. Boer May 1975 53 p refs  
(Grant NSF AER-72-03478-A03)  
(PB-252961/8; NSF/RANN/AER72-03478/PR-75-1;  
NSF/RA/N-75-182; QPR-1) Avail: NTIS HC \$14.50 CSCL  
10B

Cell processing has improved to the point whereby large (55 sq cm) and small (4 sq cm) Cu<sub>2</sub>S/CdS cells can be made with rooftop efficiencies in excess of 6 percent. Improved instrumentation and a better understanding of experimental techniques resulted in 85 percent yield during a simulated production run in the Pilot Line. The energy dispersive X-ray analyzer is capable of making scans on Cu<sub>2</sub>S surfaces. This tool can now be used to characterize structural and stoichiometric changes that occur in the Cu(x)S during cell processing and subsequent aging. Research has continued related to the application of Auger analysis to the heterojunction region. Cell lifetime, degradation and regeneration studies have continued. Cell theoretical analysis has dealt with the photovoltaic response and its dependence on such parameters as Cu<sub>2</sub>S thickness and absorption, electron diffusion length, surface recombination velocity, and drift fields. GRA

**N76-31703#** Martin Marietta Labs., Baltimore, Md.  
**BIOLOGICAL SOLAR ENERGY CONVERSION: APPROACHES TO OVERCOME YIELD, STABILITY AND PRODUCT LIMITATIONS** Progress Report, 1 Apr. - 30 Sep. 1975

Bessel Kok, C. F. Fowler, H. H. Hardt, and R. J. Radmer Sep. 1975 44 p refs  
(Grant NSF AER-73-03291)  
(PB-252925/3; MML-TR-75-38C; PR-1) Avail: NTIS  
HC \$4.00 CSCL 06A

The stability of electron transport was studied during aging of isolated chloroplasts with and without gluteraldehyde fixation. Photosystem 1 activity proved quite stable - as expected. Photosystem 2 activity was more labile; it had a half life about 3 days at 4, about 1 day at 20 degrees. The site most sensitive to aging proved to be close to the photochemical apparatus of System 2 (rather than the O<sub>2</sub> evolution system or the chain between the photoacts). Gluteraldehyde treatment caused an about 5 fold decline of the O<sub>2</sub> evolution capacity with hydrophilic electron acceptors. System 1 activity was decreased to the same extent. Little inhibition was observed with the lipophilic acceptor p-phenylenediamine. Gluteraldehyde treatment slowed down the decay of photochemical (O<sub>2</sub> evolution) activity during dark storage of chloroplasts to half lives of about 20 days at 4 and about 3 days at 20 degrees. A mass spectrometer system was assembled to measure exchange in algae. Adapted algae showed high rates of H-D exchange (hydrogenase activity). GRA

**N76-31705#** Federal Energy Administration, Washington, D.C.  
Office of Energy Resource Development.

**COAL CONVERSION PROGRAM. FINAL ENVIRONMENTAL STATEMENTS. (ENERGY SUPPLY AND ENVIRONMENTAL COORDINATION ACT OF 1974, SECTION 2)**

Apr. 1975 573 p refs  
(PB-250104/7; FEA/G-75/392; FES-75-1) Avail: NTIS  
HC \$13.50 CSCL 10A

The special authorities delegated to FEA by the Energy Supply and Environmental Coordination Act of 1974 in relation to converting certain power plants and major fuel burning installations from petroleum to coal as a source of energy are described. The current national environment in which coal conversion will take place; assessment and availability of pollution control equipment; critical air pollutants most directly affected by the Act, including the effects of coal supply, coal quality, and the availability of pollution control equipment; adverse effects of coal utilization; energy implications and environmental impacts of conversion; economic impact of programs to convert existing power plants; and the potential of coal supplies available for conversion are discussed. GRA

**N76-31706#** Mitre Corp., McLean, Va.

**WIND MACHINES**

Frank R. Eldridge Oct. 1975 85 p refs

(Grant NSF AER-75-12937)

(PB-249936/6; NSF/RA/N-75-051; MTR-6971) Avail: NTIS  
HC \$5.00 CSCL 10B

A brief survey of the viability, history, taxonomy, and future potential of various types and sizes of wind machines that might be used to help meet future U.S. energy demands is presented. It also discusses various applications of wind machines, as well as siting problems, performance characteristics, and system designs. A glossary of commonly used words and phrases, a list of suppliers, and a selected bibliography are included. GRA

**N76-31707#** Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.

**KENTUCKY ENERGY RESOURCES UTILIZATION PROGRAM** Quarterly Progress Report, 1 Apr. - 30 Jun. 1975

Sep. 1975 39 p refs

(PB-250687/1; IMMR5-PRI-75) Avail: NTIS HC \$4.00 CSCL  
08I

Progress is reported on the Kentucky Energy Resource Utilization Program during the three-month period ending June 30, 1975. The projects are grouped into the areas of Mining, including manpower development and technological projects, Process Development which includes studies on gasification and liquefaction and the improvement of ancillary processes associated with these operations, and Geology and Reserves which includes projects aimed at accelerating the evaluation of the Kentucky coal reserves and projects in reclamation and environmental effects. GRA

**N76-31748#** Stanford Research Inst., Menlo Park, Calif.

**ENERGY DEVELOPMENT: THE ENVIRONMENTAL TRADE-OFFS. VOLUME 2: RELATIVE ENVIRONMENTAL ASSESSMENT OF METHODS TO INCREASE ENERGY PRODUCTION, CRUDE OIL, PIPELINE QUALITY GAS, AND ELECTRICITY FROM WESTERN COAL** Energy and Environment Series

Mark D. Levine and Robert V. Steele Oct. 1975 132 p refs  
(Contract EPA-68-01-2469)

(PB-250001/5) Avail: NTIS HC \$6.00; HC also available in set of 4 reports as PB-249999-SET, HC \$18.00 CSCL 13B

This report concerns the development and application of a methodology for evaluating relative environmental impacts on alternative ways of producing energy. Topic areas cover the use of western coal for electricity generation, options for increasing U.S. oil production, and options for increasing pipeline quality gas supplies. GRA

**N76-32333#** Analytical Sciences Corp., Reading, Mass.

**ENERGY MANAGEMENT TECHNIQUES FOR FUEL CONSERVATION IN MILITARY TRANSPORT AIRCRAFT** Final Report, 6 Jan. 1975 - 6 Feb. 1976

Robert F. Stengel and Fred J. Marcus Wright-Patterson AFB, Ohio AFFDL Feb. 1976 222 p refs

(Contract F33615-75-C-3039; AF Proj. 1987)

(AD-A023527; TASC-TR-545-1; AFFDL-TR-75-156) Avail: NTIS CSCL 21/4

This report presents the results of an investigation of energy management techniques for fuel conservation in a large transport aircraft, the USAF C-141A. Using the methods of optimal control theory and numerical simulation, fuel-optimal flight paths are computed and compared with conventional vertical profiles for typical mission scenarios. Algorithms for on-board guidance to minimize fuel use are synthesized and evaluated, and functional requirements for system implementation are developed. Concepts for flight testing this throttle/energy management technique are presented. GRA

**N76-32588#** Little (Arthur D.), Inc., Cambridge, Mass.  
**ENERGY CONSERVATION IN NEW BUILDING DESIGN. AN IMPACT ASSESSMENT OF ASHRAE STANDARD 90-75**  
 Mar. 1976 274 p refs  
 (Contract FEA-CO-04-50173-00)  
 (PB-252639/O; FEA/D-76/078; FEA/D-CP/43B; Paper-43B)  
 Avail: NTIS HC \$9.00 CSCL 13A

The energy, economic, and institutional impacts are assessed that may result from the broad voluntary adoption of ASHRAE standard 90-75 by individual building regulatory authorities. This standard is the first major voluntary consensus standard dealing with energy use in new buildings and is available for optional acceptance by state and local governments. With strict use of the standard, annual energy consumption would be reduced in all building types and locations. The effects of ASHRAE 90-75 on building energy consumption, its influences on physical changes in the buildings, its implications on the owning and operating costs of buildings, its potential impact on the nation's energy consumption in construction, its possible economic impact on several selected markets and participants within the construction sector, and its impact on building habitability are discussed. GRA

**N76-32646** Dartmouth Coll., Hanover, N.H.  
**COAL1: A DYNAMIC MODEL FOR THE ANALYSIS OF UNITED STATES ENERGY POLICY Ph.D. Thesis**  
 Roger Francis Nail 1976 709 p  
 Avail: Univ. Microfilms Order No. 76-19860

A technical description of the data and assumptions of COAL1, a system dynamics model constructed to aid in the analysis and design of United States energy policy was presented. The following dynamic mechanisms combine to create a growing gap between domestic energy demand and production in the COAL1 model: (1) a tendency toward exponential growth in the demand for energy; (2) depletion of the domestic oil and gas resource base; and (3) delays and constraints in the development of alternative energy sources such as synthetic fuels, nuclear power or electricity from coal. With no major changes in policy, it was concluded that imports are likely to rise to 50 percent of energy needs by 1985. Only a combined program that stabilizes energy demand and accelerates the use of coal can avoid massive oil and gas imports over the long term.

Dissert. Abstr.

**N76-32652\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.  
**TESTS OF A REDUCED-SCALE EXPERIMENTAL MODEL OF A BUILDING SOLAR HEATING-COOLING SYSTEM**  
 David Namkoong Washington Sep. 1976 23 p refs  
 (NASA-TM-X-3416; E-8729) Avail: NTIS HC \$3.50 CSCL 13B

An experimental solar heating and cooling system model has been built and operated, combining elements that are programmable (e.g., heating and cooling load of a building and collected solar energy) with experimental equipment. The experimental system model was based on the loads and components used in the Solar Building Test Facility (SBTF), which includes a 1394 sq m solar collector field at NASA Langley. These tests covered 5 continuous days under summer conditions. For the system model up to 55 percent of the simulated collected solar energy was used for the building load. This amount of solar energy supplied 35 percent of the building cooling load. Heat loss was significant. If tank heat loss were eliminated, which would make it similar to the actual SBTF, 75 percent of the collected solar energy would be used. This amount would supply approximately 50 percent of the building cooling load. A higher fraction of solar energy is possible with a more performance-optimized system. Author

**N76-32656#** Oak Ridge National Lab., Tenn.  
**REGIONAL COMPARISON OF SAVINGS FROM VARIOUS RESIDENTIAL ENERGY CONVERSION STRATEGIES**  
 J. G. Delene and J. B. Gaston Feb. 1976 69 p refs  
 (Contract W-7405-eng-26)  
 (ORNL-TM-5146) Avail: NTIS HC \$6.00

The energy use and cost of providing space conditioning to a reference model home in various cities in the United States were calculated for alternate space conditioning systems and for various residential energy conservation strategies. The benefits and costs of increasing the thermal insulation in new and in older homes were estimated, as well as the value of the revised HUD minimum insulation standards compared to their predecessor. The benefits of thermostat setback and improved gas furnace efficiency were estimated from both a resource savings and consumer economic standpoint. The economic analysis included capital and maintenance, as well as costs reflected in the consumer's utility bill. Heating systems considered include heat pump, electric furnace, gas and oil furnaces, and either electric baseboard or ceiling heat. This report is intended to provide basic data for future studies. Such studies include evaluations of the potential effect of energy saving strategies and future shifts in residential heating patterns. Author (ERA)

**N76-32657#** Oak Ridge National Lab., Tenn.  
**CHOICE OF WORKING FLUID AND OPERATING CONDITIONS FOR ENERGY CONVERSION WITH GEOTHERMAL HEAT SOURCES**

K. R. Landgraf, K. I. Kudrnat, and R. Solares 23 Oct. 1973  
 68 p refs Sponsored by ERDA  
 (ORNL-MIT-180) Avail: NTIS HC \$4.50

Electric power generating cycles which can be used in conjunction with a low temperature geothermal energy source are presented. A steam/isobutane dual cycle capable of generating 50.7 MW of electric power is proposed. This cycle is optimized using regenerative feed water heating to yield a power output of 52.1 MW or an improvement of 2.8%. Other power cycle design and working fluids are investigated. Working fluids including various freons, steam, isobutane, ammonia, SO<sub>2</sub>, CO<sub>2</sub>, and several low molecular weight alkanes and alkenes are considered. The power cycle designs which are investigated include single and dual Rankine cycles as well as topping/bottoming Rankine cycles, and Brayton gas cycles. The investigation shows that use of a single freon-11 cycle results in a 57.7 MW power output representing an improvement of 13.8% over the the LASL proposal. Author (ERA)

**N76-32660#** Sandia Labs., Albuquerque, N.Mex.  
**ENGINEERING OF WIND ENERGY SYSTEMS**

James F. Banas and W. N. Sullivan Jan. 1976 27 p refs  
 (Contract AT(29-1)-789)  
 (SAND-75-0530) Avail: NTIS HC \$5.00

The engineering of wind energy systems is analyzed from the point of view of component selection and performance assessment. Combinations of two load types (variable and constant speed) and three turbine types connected by a fixed-gear-ratio transmission constitute the various systems investigated. The three turbine types result from introducing the notions of nested, unnnested, and hybrid power coefficients suggested by current performance characteristics of American Multiblade, Darrieus, and Darrieus/Savonius turbines. The engineering problems associated with these systems are discussed qualitatively, emphasizing the nature, magnitude, and variability of the problems. Author (ERA)

**N76-32661#** Atomic Energy of Canada Ltd., Pinawa (Manitoba), Whiteshell Nuclear Research Establishment.

**KINETIC ENERGY STORAGE OF OFF-PEAK ELECTRICITY**  
 L. A. Simpson, I. E. Oldaker, and J. Stermscheg Sep. 1975  
 72 p refs  
 (AECL-5116) Avail: ERDA Depository Libraries HC \$4.50; Atomic Energy of Can. Ltd., Chalk River HC \$1.50

The concept of using large flywheels to store off-peak electricity is considered. The development of high strength composite materials has made possible improvements in the energy storage capacity of such devices. The problems involved in designing large flywheels and their economic advantages over alternative means of energy storage are discussed. The economic arguments are based on the present or near future capabilities and costs of structural composite materials. The flywheel costs turn out to be considerably higher than for many alternative schemes including advanced batteries, gas turbine generators, and pumped storage schemes. Author (ERA)

**N76-32671#** Federal Energy Administration, Washington, D.C.  
**HOME HEATING, CONSERVATION ALTERNATIVES AND THE SOLAR COLLECTOR INDUSTRY**

Howard Magnus, Richard Stoll, and Howard Walton Mar. 1976  
 12 p  
 (PB-253277/8; FEA/B-76/182) Avail: NTIS HC \$3.50 CSCL 13A

An analysis of 20-year costs for retrofitting houses, with additional insulation and with solar energy systems is presented. Information is provided on the level of manufacturing activities in the solar collector industry. GRA

**N76-32673#** Stanford Research Inst., Menlo Park, Calif.  
**RESIDENTIAL HOT WATER SOLAR ENERGY STORAGE SUBSYSTEMS Final Report**

Ellis E. Pickering Jan. 1976 118 p refs  
 (Contract NSF C-905; SRI Proj. 3485)  
 (PB-252685/3; NSF/RA/N-75-095) Avail: NTIS HC \$5.50 CSCL 13A

Low-cost, efficient, and practical hot water solar energy storage subsystems for heating and cooling of residences are discussed. Both new and innovative vessel materials and configurations are investigated, together with insulation materials. Storage subsystem locations considered include basement, crawl-space, living space, garage, attic, surface exterior and underground exterior. Performance requirements for residential hot water storage systems are investigated. A matrix of advantages and disadvantages is constructed considering vessel material and configuration and location and type of residential construction. Other matters considered are corrosion control, costs, and development requirements. GRA

**N76-32674#** American Cyanamid Co., Stamford, Conn. Chemical Research Div.

**CADMIUM STANNATE SELECTIVE OPTICAL FILMS FOR SOLAR ENERGY APPLICATIONS Annual Report, 1 Jan. - 31 Dec. 1975**

G. Haacke and L. C. Burton Jan. 1976 54 p refs Prepared in cooperation with Delaware Univ., Newark.  
 (Grant NSF AER-73-07957)  
 (PB-253007/9; NSF/RANN/SE/AER73-07957/PR-75; NSF/RA-760012) Avail: NTIS HC \$4.50 CSCL 10B

Progress made during the reporting period has yielded the following results: (1) Cadmium stannate films with 6500/ohm cm conductivity and high optical transmission can be prepared by sputtering; (2) Clear cadmium stannate films with 10 to 20 ohm/square sheet resistance can be spray coated. Sheet resistances as low as 5 ohm/square have been achieved; (3) Junction-free, 1 ohm/square cadmium stannate contacts have been sputtered onto single crystal silicon wafers; and (4) Backwall efficiencies of 5.3% under tungsten illumination (about 6% AMI sunlight) were measured. Author (GRA)

**N76-32676#** National Conference of State Legislatures, Denver, Colo.

**TURNING TOWARD THE SUN. VOLUME 1: ABSTRACTS OF STATE LEGISLATIVE ENACTMENTS OF 1974 AND 1975 REGARDING SOLAR ENERGY**

1975 47 p  
 (Grant NSF ISR-1552)  
 (PB-252836/2; NSF/RA/G-75-052-Vol-1) Avail: NTIS HC \$4.00 CSCL 10A

This report identifies and abstracts all state enactments in 1974 and 1975 that directly relate to improving the prospects for solar energy applications. Specific areas of coverage are property income and sales tax incentives, state financed energy research and development of solar technologies, life-cycled cost analysis, solar provisions in state building codes, access to incident solar energy, and solar energy informational and promotional activities. State financed buildings using solar energy, and selected solar energy publications are also described briefly. GRA

**N76-32677#** National Science Foundation, Washington, D.C.  
**SUMMARY OF AWARDS IN ENERGY-RELATED GENERAL RESEARCH Final Report, 1973 - 1975**

Jan. 1976 261 p  
 (PB-252913/9; NSF-75-37) Avail: NTIS HC \$9.00 CSCL 10A

An analysis of the National Science Foundation's Research Directorate FY 1975 funding in energy related general research is given. The report includes a listing of FY 1975 energy related workshops and grants. GRA

**N76-32680#** California Univ., Davis. Inst. of Ecology.  
**LAND USE, ENERGY FLOW, AND POLICY MAKING IN SOCIETY Final Summary Report**

J. W. Young, J. L. Mitchiner, C. Ayers, Y. L. Hunter, and M. A. Pearce 1 Sep. 1975 30 p refs  
 (Grant NSF GI-27)  
 (PB-253139/0; NSF/RA/E-75-043) Avail: NTIS HC \$4.00 CSCL 10A

Modeling methodology is applied to the simulation of the use of land and energy in society. The computer aids are specifically designed for the evaluation of policy for land and energy use and not for decision making needed to implement policy. GRA

**N76-32681#** Georgia Inst. of Tech., Atlanta. Coll. of Engineering.

**EXPERIMENTAL SOLAR HEAT SUPPLY SYSTEM WITH FIXED MIRROR CONCENTRATORS FOR THE HEATING AND COOLING OF BUILDINGS Technical Report, 1 Jul. 1974 - 30 Jun. 1975**

J. Richard Williams and Samuel F. Hutchins, (Scientific Atlanta, Inc., Doraville, Ga.) Jun. 1975 49 p refs  
 (Grant NSF GI-43936)  
 (PB-252987/3; NSF/RANN/SE/GI-43936/TR-75-2; NSF/RA/N-75-298) Avail: NTIS HC \$4.00 CSCL 10A

A new type of solar collector has been assembled and tested that promises to provide heat at about the same cost as commercially available flat plate collectors, but at a much higher temperature. The higher temperature permits higher COP air conditioning and heat pump operation, with a resulting decrease in the collector area required and lower air conditioning equipment costs as compared with systems using flat plate collectors. GRA

**N76-32683#** National Bureau of Standards, Boulder, Colo. Cryogenics Div.

**RECOVERY OF HYDROGEN LIQUEFACTION ENERGY Final Report**

William R. Parrish 1975 6 p refs Presented at the Conf. on Intersoc. Energy Conversion Eng. (10th), Newark, Del., 18-22 Aug. 1975  
 (PB-252393/4) Avail: NTIS HC \$3.50 CSCL 21D

Ways of recovering part of the liquefaction energy are considered. The emphasis is on utility applications. Results show that it is technically feasible to recover 25 to 50 percent of the actual liquefaction energy if a MHD generator is used; recovery factors of approximately 18 percent could be obtained with gas turbines and lower recovery factors of 8 to 20 percent are possible if fuel cells are used. This energy recovery has the net effect of lowering the required liquefaction energy which makes liquid a more attractive means of storage. GRA

**N76-32694#** McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

**DESIGN, FABRICATION, AND TEST OF A HELIOSTAT FOR A CENTRAL RECEIVER SOLAR THERMAL POWER PLANT Project Technical Report, May 1974 - Sep. 1975**

J. B. Blackmon Sep. 1975 265 p refs Prepared in cooperation with Houston Univ., Tex.  
 (Grant NSF GI-39456)  
 (PB-252667/1; MDC-G6043; NSF/RA/N-75-288) Avail: NTIS HC \$9.00 CSCL 10B

A full scale central pedestal mounted elevation/azimuth heliostat was designed, fabricated, and tested. The structural

support was mounted on a drive housing equipped with a linear actuator for control of the elevation axis, and a harmonic drive for azimuth control. A quadrant photosensor mounted on a separate pedestal and aligned along the target mirror of sight provided error signals to an analog circuit that provided properly apportioned steering commands to the dc motors on the elevation/azimuth movement. Tracking and beam dispersion characteristics were investigated at six typical positions. GRA

**N76-32703#** Federal Energy Administration, Washington, D.C.  
**ENERGY CONSERVATION SITE VISIT REPORT: TOWARD MORE EFFECTIVE ENERGY MANAGEMENT**  
 Apr. 1976 92 p refs Prepared in cooperation with General Services Admin., and Office of Management and Budget (PB-253279/4; FEA/D-76/002; Paper-38) Avail: NTIS HC \$5.00 CSCL 10A

The results of visits to 287 Federal installations to investigate the effectiveness of energy conservation efforts are presented. Although energy use has been reduced significantly further energy conservation is possible in buildings; motor vehicle management; employee transportation systems; and aircraft, ship, and tactical equipment use. In many cases, future energy conservation activities will entail capital investment to improve energy efficiency. Elements of an effective energy conservation program are listed: top management commitment; accountability; formal planning; monitoring; technical expertise utilized; employee awareness; contingency planning; and resource support. This report is designed to be used as a resource for managers in planning energy conservation procedures and programs. GRA

**N76-32704#** Transportation Research Board, Washington, D.C.  
**TRANSPORTATION ENERGY CONSERVATION AND DEMAND**

John F. Sacco 1976 77 p refs  
 (PB-252904/8; TRB/TRR-561; ISBN-0-309-02471-4) Avail: NTIS HC \$5.00 CSCL 10A

Contents: impact of the energy shortage on travel patterns and attitudes; evaluation of interaction between rural regional transportation and energy availability; energy savings for work trips-analysis of alternative commuting patterns for New Jersey; gasoline demand by owner characteristics; gasoline use by automobiles; totality indexes for evaluating environmental impacts of highway alternatives. GRA

**N76-32705#** Federal Energy Administration, Washington, D.C.  
 Office of Trade Resources.

**REPORT TO THE CONGRESS ON THE FEASIBILITY OF LOWERING THE PRICE OF US OIL IMPORTS BY PROVIDING INCENTIVES TO DOMESTIC PRODUCER/IMPORTERS**

John Treat Mar. 1976 100 p  
 (PB-253276/0; FEA/M-76/223) Avail: NTIS HC \$5.00 CSCL 10A

The feasibility of reducing the price of U.S. oil imports by providing incentives to those domestic oil producers who are also oil importers is assessed. The principal conclusion is that the prospects of a significant reduction of import prices in the near future through new incentive programs are not promising. In the longer term, incentives to expand domestic production and reduce consumption could eventually shrink U.S. import demand and, when added to exploration and development of new world supplies outside the major OPEC countries and reduction of demand in other major consuming countries, could exert downward pressure on OPEC prices. GRA

**N76-32709#** Data Resources, Inc., Cambridge, Mass.  
**THE INTEGRATION OF ENERGY POLICY MODELS** Interim Report

Ben Bernanke and Dale W. Jorgenson Jul. 1975 77 p refs (Grant NSF GI-43097) (PB-246984/9; NSF/RA/N-75-101) Avail: NTIS HC \$5.00 CSCL 21D

This report presents an integrated model for the assessment of alternative U.S. energy policies, based on the inter-industry

model and the natural gas model. Also presented is a methodology for integrating energy policy models, which imposes certain consistency requirements on alternative models of the same phenomena. This methodology is applied to the incorporation of exploration and development and wellhead price regulation of natural gas into the integrated energy policy model. Finally presented are four policy simulations with the integrated model. These simulations are the four possible combinations of quotas on oil imports versus no quotas and phased deregulation of the price of natural gas versus no deregulation. GRA

**N76-32712#** Office of Technology Assessment, Washington, D.C.

**AN ANALYSIS OF THE ERDA PLAN AND PROGRAM**

Oct. 1975 328 p  
 (PB-250636/8; OTA-E-12) Avail: NTIS HC \$10.00 CSCL 10A

This report is an analysis of the energy research and development programs of the Energy Research and Development Administration (ERDA). The analysis was performed primarily by task groups assembled to cover each of ERDA's major programmatic areas: (1) fossil energy; (2) nuclear energy; (3) solar geothermal, and advanced technologies; (4) conservation; and (5) environment and health. Since the ERDA plans reflect the President's view of national energy R and D policy, they will in large measure determine the broader options for our future national energy policy; this assessment is intended to provide the Congress with much of the background information necessary for an effective analysis of the ERDA programs. GRA

**N76-33359#** National Bureau of Standards, Washington, D.C.  
 Inst. for Applied Technology.

**ENERGY CONSERVATION THROUGH THE FACILITATION OF INCREASED BLENDED CEMENT USE** Interim Report, 1 Jul. - 1 Dec. 1975

Paul Wencil Brown, James R. Clifton, and Geoffrey Frosdorff Feb. 1976 28 p refs Sponsored by ERDA (PB-251218/4; NBSIR-76-1008) Avail: NTIS HC \$4.00 CSCL 13C

Portland cement manufacture requires about 2% of the energy consumed annually in the nation's industrial processes. The production of blended cements containing substantial amounts of fly ash or blast furnace slag and their substitution for Portland cement appears attractive from the standpoint of energy conservation. Blended cements account for less than 1% of the total cement production in the U.S. The reasons for the small U.S. production of blended cements are discussed in the contexts of standards revision and the need for the development of additional data as a basis for this revision. GRA

**N76-33622\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**INITIAL OPERATION OF A SOLAR HEATING AND COOLING SYSTEM IN A FULL-SCALE SOLAR BUILDING TEST FACILITY**

Richard H. Knoll, David Miao, Irvin L. Hamlet, and Ronald N. Jensen 1976 18 p refs Presented at Intern. Solar Energy Soc. Conf., Winnipeg, Canada, 15-20 Aug. 1976 (NASA-TM-X-73519; E-8931) Avail: NTIS HC \$3.50 CSCL 10A

The Solar Building Test Facility (SBTF) was constructed to advance the technology for heating and cooling of office buildings with solar energy. Its purposes are to (1) test system components which include high-performing collectors, (2) test the performance of a complete solar heating and cooling system, (3) investigate component interactions, and (4) investigate durability, maintenance and reliability of components. The SBTF consists of a 50,000 square foot office building modified to accept solar heated water for operation of an absorption air conditioner and for the baseboard heating system. A 12,666 square foot solar collector field with a 30,000 gallon storage tank provides the solar heated water. A description of the system and the collectors selected is printed along with the objectives, test approach, expected system performance, and some preliminary results. Author

**N76-33623\*** Alabama Univ., Huntsville. Center for Environmental and Energy Studies.

**SOLAR HEATING AND COOLING TECHNICAL DATA AND SYSTEMS ANALYSIS Interim Status Report, Sep. 1975 - Aug. 1976**

D. L. Christensen Sep. 1976 38 p  
(Contract NAS8-31298)

(NASA-CR-150012) Avail: NTIS HC \$4.00 CSCL 10A

The accomplishments of a project to study solar heating and air conditioning are outlined. Presentation materials (data packages, slides, charts, and visual aids) were developed. Bibliographies and source materials on materials and coatings, solar water heaters, systems analysis computer models, solar collectors and solar projects were developed. Detailed MIRADS computer formats for primary data parameters were developed and updated. The following data were included: climatic, architectural, topography, heating and cooling equipment, thermal loads, and economics. Data sources in each of these areas were identified as well as solar radiation data stations and instruments.

D.M.L.

**N76-33625\*** Kanner (Leo) Associates, Redwood City, Calif.  
**ENERGY REQUIREMENT FOR ELECTRIC ROAD VEHICLE PROPULSION**

U. Hahn Washington: NASA Sep. 1976 11 p refs Transl. into ENGLISH from Bosch Tech. Ber. (Stuttgart), v. 2, no. 5, Nov. 1968 p 207-210  
(Contract NASw-2790)

(NASA-TT-F-17226) Avail: NTIS HC \$3.50 CSCL 10B

The energy balance is established on the basis of a flow diagram for the energy in an electrically-propelled road vehicle. In addition to energy restoration, the accelerated masses, the efficiencies of the energy source and the transmission means, and the possible secondary points of energy consumption are taken into account. The quantitative energy requirements are given. It is shown that the requirements of a simple vehicle for town traffic can be met within the present state of technical development.

Author

**N76-33635\*** California Univ., Livermore. Lawrence Livermore Lab.

**WIND POWER STUDIES: INITIAL DATA AND NUMERICAL CALCULATIONS Progress Report, Sep. - Dec. 1975**

D. M. Hardy 15 Oct. 1975 44 p refs  
(Contract W-7405-eng-48)

(UCRL-50034-76-1) Avail: NTIS HC \$4.00

Initial data collection and numerical modeling results in wind energy research conducted by the Lawrence Livermore Laboratory are reported. The use of conventional and laser anemometry is described. Also discussed is the development of a data collection and data processing capability appropriate for a major numerical study of wind energy as well as a three-dimensional numerical model of wind fields over complex terrain. Illustrative numerical calculations of nondivergent vector wind fields are presented.

Author. (ERA)

**N76-33636\*** Idaho National Engineering Lab., Idaho Falls.  
**GEOHERMAL STEAM PLANT MODELING AND POWER TRADEOFF STUDIES**

C. J. Shaffer Jan. 1976 60 p refs  
(Contract E(10-1)-1375)

(ANCR-1295) Avail: NTIS HC \$5.50

A computer model of an open loop flashed steam plant for producing electrical power from a hot geothermal water supply is documented. The model has the capability of tracing the dissolved gases, N<sub>2</sub> and CO<sub>2</sub>, throughout the plant. Sensitivity

studies were performed on several of the geothermal source, design, and atmospheric parameters using the source conditions found in the Raft River Valley as a base case.

ERA

**N76-33638\*** Battelle Pacific Northwest Labs., Richland, Wash.  
**COMPARISON OF SOLAR POND CONCEPTS FOR ELECTRICAL POWER GENERATION**

K. Drumheller, J. B. Duffy, O. K. Harling, C. A. Knutsen, M. A. McKinnon, P. L. Peterson, L. H. Shaffer, D. L. Styris, and R. Zaworski Oct. 1975 128 p refs

(Contract E(45-1)-1830)

(BNWL-1951) Avail: NTIS HC \$5.45

Various solar pond concepts for electric power generation were identified, including but not limited to: (1) nonconvective salt gradient solar pond; (2) ponds with various plastic or other membranes at suitable locations to minimize or eliminate convection; (3) ponds which are totally or partially gelled to reduce or eliminate convection; and (4) shallow convecting ponds. The performance of these various concepts was analyzed and compared. The pond cost and overall power plant system cost for each concept assuming the nonconvective gradient salt pond as the base case were estimated. The approach included a preliminary design of several power plant systems based on solar pond concepts, and performance and economic evaluation based on these preliminary designs.

ERA

**N76-33641\*** Energy Research and Development Administration, Washington, D.C.

**ENERGY TRANSFER AND ENERGY STORAGE**

W. Heinz 1974 21 p refs Transl. into ENGLISH from German Report VDI-208

(ERDA-TR-83; VDI-208) Avail: NTIS HC \$3.50

The increasing consumption of electrical energy together with the growing proportion of nuclear energy as a primary energy source require new concepts both with respect to energy transfer as well as energy storage. Research on the use of low temperature technology is reported. Other advanced transfer and storage systems are compared.

Author (ERA)

**N76-33647\*** Northwestern Univ., Evanston, Ill.  
**BASIC RESEARCH ON CERAMIC MATERIALS FOR ENERGY STORAGE AND CONVERSION SYSTEMS Progress Report, 1 Apr. - 30 Nov. 1975**

D. H. Whitmore Dec. 1975 7 p  
(Contract E(11-1)-2564)

(COO-2564-1) Avail: NTIS HC \$3.50

Probes were used for movement of ionic and electronic charge carriers in ceramic materials suitable for solid electrolyte and electrode applications in high performance, secondary battery, and fuel cell systems. Special emphasis is placed on developing a better understanding of the effects of structure, impurities, and composition on transport mechanisms and on developing detailed knowledge of the kinetics and mechanisms of reactions occurring (on a microscopic scale) at the electrode-electrolyte interfaces of energy storage and conversion systems.

Author. (ERA)

**N76-33648\*** Sandia Labs., Albuquerque, N.Mex.

**ANALYSIS OF A SOLAR TOTAL ENERGY SYSTEM**

B. W. Marshall 1975 28 p refs Sponsored by ERDA  
(TID-26914) Avail: NTIS HC \$5.00

A solar system to provide the electrical, thermal, and hot water requirements of a hypothetical 1000-home community was

analyzed. The community is located in Albuquerque, New Mexico, and real 1962 solar and weather data were used. The system is composed of parabolic cylindrical collectors, high and low temperature storage systems, a turbogenerator, cooling towers, auxiliary fossil fuel furnaces, a thermal distribution system, and necessary pumps and controls. The system performance for four collector areas was evaluated and the fossil fuel savings ranged from 36 to 79 percent. Using the criteria of overnight storage combined with minimum waste of solar energy, a system with a total collector area of 24390 sq. m. was found to be near optimum. Economic analyses suggest that over the next 30 years, energy from the solar system would be less than 1.5 times more expensive than energy supplied to the home by conventional electric and natural gas means and this factor can be reduced, by solar economic incentives and higher than predicted fossil fuel prices. Author (ERA)

**N76-33650# Atomic Energy of Canada Ltd., Pinawa (Manitoba): ASSESSMENT OF THE UTILIZATION OF WASTE HEAT IN GREENHOUSES**

S. L. Iverson, D. R. Prowse, and J. D. Campbell Jan. 1976 111 p refs  
(AECL-5109) Avail: ERDA Depository Libraries HC \$5.50

The economic feasibility of utilizing waste heat from the moderator circuit of the CANDU G-2 reactor to heat greenhouses was examined. Waste heat recovery systems were compared to a conventional gas-fired em. Each waste heat recovery system involved the recirculation of warm light water from modified moderator heat exchangers through a distribution system to finned-tube heat exchangers in the greenhouses. The distribution system was assumed to service an 8 or 10 hectare (20-25 acre) greenhouse vegetable industry located immediately outside the 914 m reactor exclusion zone. The lowest calculated heating and ventilation costs for waste heat systems were \$9.55 per year per square meter of growing surface for the climate of Winnipeg, Manitoba. A conventional greenhouse heated by natural gas would experience the same annual heating costs. Potential improvements to the waste heat utilization system were discussed, each of which would make the system economically competitive at current natural gas prices. Author (ERA)

**N76-33651# California Univ., Berkeley. TOWARDS MORE PRODUCTIVE ENERGY UTILIZATION**  
L. Schipper 1 Oct. 1975 82 p refs Presented at the Ann. Meeting of Am. Assoc. for the Advan. of Sci., Boston, 24 Feb. 1976

(Contract W-7405-eng-48)  
(LBL-3299; Conf-760217-2) Avail: NTIS HC \$5.00

The nature of energy use and strategies which increase the efficiency of energy use are discussed. Measures of physical and economic efficiency are discussed. It is suggested that specific energy requirements of tasks in the United States could be reduced by 33 to 40 percent over the next few decades at cost savings to energy users. Most of the energy conservation strategies required would have only a slight effect on life style, as well. In addition to saving energy and money, higher energy use efficiency raises the total demand for labor in the economy, lowers pollution, reduces the total capital requirements of future energy activities, and allows society to proceed cautiously with risky or marginal energy sources. Many barriers to more efficient energy utilization exist, barriers whose solutions are socio-economic or political rather than technical. These barriers are reviewed, and some suggestions are made which would allow society to overcome them in seeking to use energy more efficiently than today. ERA

**N76-33654# Sandia Labs., Albuquerque, N.Mex. MAGMA ENERGY RESEARCH PROJECT Project Summary, 1 Jul. 1974 - 30 Jun. 1975**

J. L. Colp, M. J. Davis, E. J. Graeber, and H. C. Hardee Mar. 1976 38 p refs  
(Contract AT(29-1)-789)  
(SAND-75-0451) Avail: NTIS HC \$4.00

The feasibility of extracting energy directly from deeply buried, circulating magma sources is discussed. Project plans describe

a concept whereby a fully closed heat exchanger system is inserted directly into such a magma source to allow the heat energy to be brought to the surface with minimal environmental impact. A summary of previous efforts is given. The achievements and future plans for source location and definition, source tapping, magma characterization, magma materials compatibilities studies, and energy extraction studies are outlined. ERA

**N76-33655# California Univ., Livermore. Lawrence Livermore Lab.**

**ESTIMATE OF THE GEOTHERMAL ENERGY RESOURCE IN THE SALTON TROUGH, CALIFORNIA**

D. Towse 12 Feb. 1976 25 p refs

(Contract W-7405-eng-48)

(UCRL-51851-Rev-1) Avail: NTIS HC \$3.50

The geothermal energy resource in the Salton Trough was estimated based on measured geologic parameters, extrapolation of data from geophysical surveys, and research in energy conversion systems. The total resource is estimated at 2 x 10 to the 19th power J contained in 15 x 10 to the 12th power kg of water, the quality of which varies from fresh to over 25 percent dissolved solids. More than one-half of the resource is in the high saline deposit at the Salton Sea. It is estimated that 8 x 10 to the 8th power MWh of electric energy, equivalent to 5,000 MW for 20 yr, could be generated. This is a substantial part of the present electric power requirements of Southern California and is the energy equivalent of 1.3 billion barrels of oil. ERA

**N76-33657# Laboratorio di Ricerca e Tecnologia per lo Studio del Plasma nello Spazio, Frascati (Italy).**

**SOLAR ENERGY PRELIMINARY STUDY: A SELF-SUPPLIED MEASUREMENT STATION [STUDIO PRELIMINARE SULL'ENERGIA SOLARE: UNA STAZIONE DI MISURA AUTOALIMENTATA]**

G. Balestrino, A. Egidi, and G. V. Pallottino Dec. 1975 38 p refs In ITALIAN

(LPS-75-36) Avail: NTIS HC \$4.00

Prospects and perspectives of photovoltaic cells as solar generators are reviewed. An electronic device was designed and constructed in order to measure and record time performance of two silicon photovoltaic cell panels and to compare the performance of solar generators vs standard pyrometers. The operational characteristics of the measuring system, the signal processing, and the recording systems are described together with the principles of measuring the power, the short circuit current, and other parameters inherent in the performance of photovoltaic cells. ESA

**N76-33658# AAI Corp., Baltimore, Md. PRODUCTION OF METHANE USING OFFSHORE WIND ENERGY, EXECUTIVE SUMMARY**

R. B. Young, A. F. Tiedemann, Jr., L. G. Marianowski (Inst. of Gas Technol., Chicago), and E. H. Camara (Inst. of Gas Technol., Chicago) Nov. 1975 35 p

(Contract NSF C-993)

(PB-252308/2; AAI-ER-8447; NSF/RA/N-75-295A) Avail: NTIS HC \$4.00 CSCL 07A

The potential of the electrical generation by wind energy of hydrogen, converting it to methane, and introducing it into natural gas pipelines was assessed. The electrochemical process was defined along with the theoretical feasibility and the estimated cost of producing methane gas from wind energy using calcium carbonate from underwater sands. The site locations used were Nantucket Shoals off the coast of Massachusetts and Cape Hatteras shoal water areas. GRA

**N76-33659# AAI Corp., Baltimore, Md. PRODUCTION OF METHANE USING OFFSHORE WIND ENERGY**

R. B. Young, A. F. Tiedemann, Jr., L. G. Marianowski (Inst. of Gas Technol., Chicago), and E. H. Camara (Inst. of Gas Technol., Chicago) Nov. 1975 79 p refs

(Contract NSF C-993)

(PB-252307/4; AAI-ER-8447-F; NSF/RA/N-75-295) Avail: NTIS HC \$5.00 CSCL 07A

The feasibility of converting wind energy to methane gas was investigated. The basic approach consists of using offshore winds to drive generators which supply electricity to electrolysis cells. Electrolysis of distilled sea water produces hydrogen. Carbon dioxide is derived from underwater carbonate deposits. These gases are combined to form methane. The methane gas produced by the process can be used in existing natural gas-burning equipment, thus conserving a valuable capital investment. GRA

**N76-33660#** Federal Energy Administration, Washington, D.C. Nuclear Energy Analysis Div.

**SOLAR COLLECTOR MANUFACTURING ACTIVITY Semi-annual Report, Jul. - Dec. 1975**

Howard L. Magnas Mar. 1976 16 p 2 Vol.  
(PB-252196/1; FEA/B-76-161) Avail: NTIS HC \$3.50 CSCL 13A

Private firms that manufactured and sold solar collectors during the second half of calendar year 1975 were surveyed. Statistics on economic activity in the solar heating and cooling area were obtained and production growth rates were identified. Results of earlier surveys covering calendar year 1974 and the first 6 months of 1975 were used for making baseline comparisons. GRA

**N76-33665#** National Swedish Inst. for Building Research, Stockholm.

**ENERGY CONSERVATION IN BUILDINGS, R AND D**

1976 63 p refs  
(PB-253429/5; D1:1976; ISBN-91-540-2537-0) Avail: NTIS HC \$4.50 CSCL 10A

Research and development projects in Sweden are discussed. Projects relate to energy use in industrial processes, transport, communications, and indoor comfort; retrieval of energy from goods; energy production; and general energy systems analysis. GRA

**N76-33666#** California Univ., Berkeley. Lawrence Berkeley Lab.

**A QUADRATIC PROGRAMMING ANALYSIS OF ENERGY IN THE UNITED STATES ECONOMY Final Report**

C. Roger Glassey and Peter Benenson Dec. 1975 83 p refs (Proj. 263-1)  
(PB-252209/2; EPRI-ES-116; EPRI-RP-263-1-F) Avail: NTIS HC \$5.00 CSCL 21D

A linear programming input-output model of the U.S. economy is described. The elasticity of demand for various commodities is included in the model. The model is greatly simplified by aggregating to 20 economic sectors and by assuming that the final demand for each sector output is a linear function of its own price. An equilibrium state of model economy is calculated by maximizing a quadratic function subject to the same kind of constraints that appear in the linear programming model, i.e., by solving a quadratic program. The input data was varied to simulate four scenarios. GRA

**N76-33667#** Federal Energy Administration, Washington, D.C. Office of Oil and Gas Analysis.

**UNDERGROUND STORAGE OF NATURAL GAS IN THE UNITED STATES**

Albert F. Bass and James McCarrick Mar. 1976 17 p refs (PB-250363/9; FEA/B-76/088) Avail: NTIS HC \$3.50 CSCL 21D

This report is the first effort to survey underground gas storage on a heating season basis for the entire United States. The survey covered 80 storage operators who reported 375 storage reservoirs in 26 states with a total reservoir capability of 6.364 Bcf. The report contains tables which indicate total amount of gas in storage at the beginning of the 1974 heating season, the amount injected and withdrawn during the following year, and the amount of gas in storage at the beginning of the following heat season; tables listing underground gas storage by operator, November 1, 1974 - November 1, 1975; and a map illustrating the distribution of natural gas storage reservoirs in the United States. GRA

**N76-33668#** Transportation Systems Center, Cambridge, Mass. **ENERGY STATISTICS: A SUPPLEMENT TO THE SUMMARY OF NATIONAL TRANSPORTATION STATISTICS Final Report**

William F. Gay Aug. 1975 155 p  
(PB-252612/7; DOT-TSC-OST-75-33) Avail: NTIS HC \$6.75 CSCL 10A

Selected time-series data describing the transportation, production, processing, and consumption of energy are presented. Revenues and expenses of oil pipeline companies, number and capacities of U.S. tank ships, the total crude oil transported in the U.S. by method of transportation; growth over time of the U.S. oil and natural gas reserves, refinery capacity and yields; and trends in the demand for fuel and power are discussed. GRA

**N76-33669#** Oklahoma Univ., Norman. Science and Public Policy Program.

**FIRST YEAR WORK PLAN FOR A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT Final Socioeconomic Environmental Studies Series**

Irvin L. White, Michael A. Chartock, Leon Leonard, Cary N. Bloyd, Martha W. Gilliland et al Mar. 1976 346 p refs Prepared in cooperation with Radian Corp., Austin, Tex.  
(Contract: EPA-68-01-1916)

(PB-252034/4; EPA-600/5-76-001) Avail: NTIS HC \$10.00 CSCL 10A

The energy resources addressed are coal, oil shale, oil, natural gas, geothermal, and uranium. The geographical focus is on the states of North and South Dakota, Montana, Wyoming, Utah, New Mexico, Arizona and Colorado. The time frame to be addressed is the period 1975-2000. The Assessment is designed to identify and quantify the diverse impacts of energy development in the West, including secondary or higher order impacts. Further, the assessment will identify and assess policy alternatives for dealing with these impacts, with a special focus on environmental protection strategies. Nine scenarios are used to structure the analysis. GRA

**N76-33670#** Federal Energy Administration, Washington, D.C. **NATIONAL ENERGY OUTLOOK: 1976**

Feb. 1976 591 p refs  
(PB-252224/1; FEA/N-75/713) Avail: NTIS HC \$13.75 CSCL 10A

During the last year (1975), a number of significant international and domestic events occurred which will change The United States' energy future. This report captures these changes and represents the first of an annual series of energy forecasts. The forecasts through 1990 are based on improved versions of the national energy supply and demand models FEA has developed during the last two years, and uses the most up-to-date data which are collected. GRA

**N76-33671#** Washington State Univ., Pullman.

**SOCIETAL IMPLICATIONS OF ENERGY SCARCITY. SOCIAL AND TECHNOLOGICAL PRIORITIES IN STEADY STATE AND CONSTRICTING SYSTEMS**

Lewis F. Carter, Louis N. Gray, Theodore Greenstein, Toby Jayaratne, and Gerald Williams Mar. 1976 191 p refs (PB-252384/3; NSF/ERG-76-3) Avail: NTIS HC \$7.50 CSCL 10A

The results of a two day seminar that brought together academics with related research interests, representatives of business and industries which either produce or consume large quantities of energy, and representatives of interested state and regional governments are reported. The seminar participants (1) assessed the utility and appropriateness of several major sociological perspectives for predicting population responses to scarcity; (2) determined areas of social organization most likely to be impacted by continuing (or worsening) conditions of scarcity and likely forms of social reorganization or adjustment; (3) developed a programmatic research statement indicating where critical information is lacking and priorities for research, and (4)



began a dialog concerning the common interests of academic social scientists, energy producing industries, and representatives of state and regional agencies likely to be influenced by social changes related to energy shortages. GRA

**N76-33677#** West Virginia Univ., Morgantown. Dept. of Aerospace Engineering.

**INNOVATIVE WIND MACHINES Six Month Report, 1 Mar. - 31 Aug. 1975**

Richard E. Walters, Jerome B. Fanucci, John L. Loth, Nathan Ness, and G. Michael Palmer Sep. 1975 160 p refs (Grant NSF AER-75-00367-000)

(PB-252617/6; NSF/RA/N-75-223; TR-47) Avail: NTIS HC \$6.75 CSCL 10B

Theoretical and experimental research concerning the evaluation of two concepts for wind (energy conversion) machines are described. The first concept is that of a vortex concentrator: a high lift vertical airfoil in the ambient wind generates a trailing vortex which has its energy harnessed by a relatively small high speed turbine located just downstream of the wing tip. The device concentrates wind energy so that for a given size turbine the potential power output is greatly increased. The second concept described is that of a vertical axis panemone device with circulation controlled airfoils for the blades. GRA

**N76-33679#** RAND Corp., Santa Monica, Calif.  
**THE POTENTIAL OF INDIGENOUS ENERGY RESOURCES FOR REMOTE MILITARY BASES Interim Report**

T. T. Connors, P. F. Morrison, C. C. Mow, and R. G. Salter Mar. 1976 141 p refs

(Contract DAHC15-73-C-0181; ARPA Order 189) (AD-A022829; R-1798-ARPA) Avail: NTIS CSCL 10/2

An examination of the potential of solar radiation, wind, and ocean waves to provide thermal and electrical power to standard remote military bases. Sufficient energy is shown to be available in the North Atlantic, Indian, and Pacific Oceans, and the Caribbean to satisfy average remote base power requirements. A survey of indigenous energy technologies indicates that considerable research is needed to bring wave power recovery up to the level of solar and wind systems. An analytic computer model is used to show that indigenous energy systems are extremely costly, in part because of storage requirements, and that a mix of indigenous and conventional (petroleum) systems would be far less so. Since even a combined system is shown to exceed the cost of a pure conventional power supply, use of indigenous energy is justifiable only as a means of reducing the dependence of remote bases on petroleum fuels. Author (GRA)

**N76-33682#** Office of Technology Assessment, Washington, D.C.

**AN ANALYSIS OF THE IMPACT OF THE PROJECTED NATURAL GAS CURTAILMENTS FOR THE WINTER 1975-76**

Nov. 1975 41 p refs

(PB-250623/6; OTA-E-13) Avail: NTIS HC \$4.00 CSCL 21D

Natural gas curtailments have been a continuing and growing phenomena since 1970, and are projected for the winter of 1975-76 at a level that would cause severe constraints on economic activity. The objectives of this study are to determine the extent to which these projected curtailments reflect the actual situation and what the impacts and potential danger points might be as a result of the natural gas shortage. A list is presented of important issues which are intimately related to the overall problem of natural gas shortages and need to be addressed in determining its solution. GRA

**N76-33684#** Transportation Research Board, Washington, D.C.  
**ENERGY USE IN TRANSPORTATION: POTENTIAL FOR COOPERATIVE RESEARCH**

H. W. Bruck 1975 148 p Sponsored by DOT

(PB-250503/0) Avail: NTIS MF \$2.25; HC available from Transportation Research Board, 2101 Constitution Ave., N. W., Washington, D. C. 20418 CSCL 10A

Findings are outlined of a group of researchers sent by the Transportation Research Board, under contract with the U.S. Department of Transportation, to selected European countries and multinational organizations to inquire into the possibilities and prospects of research cooperation in the field of energy use in transportation. GRA

**N76-33686#** Army Construction Engineering Research Lab., Champaign, Ill.

**TOTAL ENERGY AND TOTAL UTILITY SYSTEMS FOR CONSERVATION OF RESOURCES Interim Report, Jul. 1973 - Jun. 1974**

Douglas C. Hittle Mar. 1976 34 p

(DA Proj. 4A7-6720-A-896)

(AD-A023244; CERL-IR-E-61) Avail: NTIS CSCL 10/1

This report describes the problems encountered in the feasibility assessment and design of total energy/total utility systems, outlines the general framework of a computational model for solving these problems and describes the data required to validate such a model. Author (GRA)

**N76-33695#** Delaware Univ., Newark. Inst. of Energy Conversion.

**PHOTOVOLTAICS IN HETEROJUNCTIONS, PARTICULARLY CdS/Cu2S (DIRECT SOLAR ENERGY CONVERSION FOR LARGE SCALE TERRESTRIAL USE)**

A. Rothwarf Jun. 1975 46 p refs

(Grant NSF AER-72-03478-A03)

(PB-252286/0; NSF/RA/N-75-286;

NSF/RANN/AER72-03478-A03/TR-75)

Avail: NTIS

HC \$4.00 CSCL 10B

An overview of the operation of the Cu2S-CdS solar cell is given in terms of heterojunction theory. The factors determining the open circuit voltage, fill factor, and short circuit current are treated. The short circuit current's dependence on the mode of operation of the cell, on the Cu2S parameters: absorption coefficient, diffusion length, thickness, grain size, drift fields, and surface recombination and on the CdS parameters: space charge field, mobility, and interface recombination velocity is discussed. The dependence on the open circuit voltage on the difference in work functions between Cu2S and CdS and the mechanisms for the dark diode current is shown. GRA

**N76-33697#** National Bureau of Standards, Washington, D.C. Building Environment Div.

**GOVERNMENT ACTIVITIES AND REGULATIONS FOR BUILDINGS ON ENERGY SAVING STANDARDS. A LOOK AT WHAT VARIOUS AGENCIES HAVE DONE AND INTEND TO DO FOR ENERGY CONSERVATION Final Report**

Paul R. Achenbach Dec. 1975 8 p Repr. from Heating/Piping/Air Conditioning, v. 47, Dec. 1975 p 13, 41-46

(PB-252399/1) Avail: NTIS HC \$3.50 CSCL 13A

Existing documents relating to retrofit are identified, along with documents in development for both new and extant buildings with potential impact on regulations, standards, and codes, if the energy shortage persists. GRA

**N76-33698#** Maryland Univ., College Park. Dept. of Mechanical Engineering.

**WORKSHOPS ON SOLAR COLLECTORS FOR HEATING AND COOLING OF BUILDINGS Final Summary Report, 15 Aug. 1974 - 31 Dec. 1975**

Stephen L. Sargent Dec. 1975 13 p

(Grant NSF AER-74-24639)

(PB-252977/4; NSF/RA/N-75-292) Avail: NTIS HC \$3.50 CSCL 13A

This report concentrates on the mechanics of organizing and running the workshop and publishing the proceedings, in hope that this discussion will be useful to people planning future solar energy workshops. GRA

**N76-33699#** Massachusetts Inst. of Tech., Cambridge. Energy Lab.

**AN APPLICATION OF A GENERALIZED MANAGEMENT INFORMATION SYSTEM TO ENERGY POLICY AND DECISION MAKING: THE USER'S VIEW**

John J. Donovan, Louis M. Gutentag, Stewart E. Madnick, and Grant N. Smith May 1975 25 p refs Submitted for publication Sponsored by New England Regional Commission, Boston (PB-252980/8; MIT-EL-75-008) Avail: NTIS HC \$3.50 CSCL 10A

An approach to the development and use of management information systems is presented. This approach is particularly applicable to systems that: have several types of users with varying degrees of sophistication; have complex or changing security requirements; exhibit complex and changing interrelationships in data; must be built quickly and inexpensively; have complex data validation requirements; and/or must meet changing needs. The type of system described is hierarchical because it may be accessed at distinct levels: A casual user has high level primitives to work with, while an experienced user has more flexible but more detailed low-level primitives. Hierarchical systems also provide for ease of debugging, independence of hardware, and a basis for investigating properties of completeness, integrity, correctness, and performance. GRA

**N76-33700#** Midwest Research Inst., Kansas City, Mo.  
**ENERGY CONSERVATION IMPLICATIONS OF MASTER METERING, VOLUME 1 Final Report**  
Gordon E. Gross, Richard D. Harper, and Steve Ahlstrom Washington FEA Oct. 1975 84 p refs 2 Vol.  
(Contract FEA-C-04-50067-00)  
(PB-254322/1; FEA/D-76/110-Vol-1) Avail: NTIS HC \$5.00 CSCL 10A

Master metering of electrical service in apartment and office buildings was investigated. The objectives of the study were to determine: (1) the difference between electrical energy consumption by tenants with master metered electric service and those who must pay individual electric bills; (2) the extent and trends of the use of master metering of electrical service in apartment and office buildings; (3) the economic and other factors which influence the initial selection or later conversion to master or individual metering; and (4) to provide and evaluate policy alternatives which could control the practice of master metering. GRA

**N76-33701#** Midwest Research Inst., Kansas City, Mo.  
**ENERGY CONSERVATION IMPLICATIONS OF MASTER METERING, VOLUME 2: APPENDICES Final Report**  
Gordon E. Gross, Richard D. Harper, and Steve Ahlstrom Washington FEA Oct. 1975 146 p 2 Vol.  
(Contract FEA-C-04-50067-00)  
(PB-254323/9; FEA/D-76/111-Vol-2) Avail: NTIS HC \$6.00 CSCL 10A

The seven appendices contain the following: (1) examples of electricity rate structures; (2) names and addresses of information sources used in this study; (3) responses from 47 state public service commissions on their stand on master metering; (4) comparison of electricity consumption between master-metered apartments and individual-metered; (5) extent of master metering from the Census of Housing 1970; (6) reports and information on load and consumption studies; and (7) utility and real estate management comments. GRA

**N76-33702#** Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.  
**SYNTHETIC OIL FROM COAL Semiannual Report, 1 Jul. - 31 Dec. 1975**  
Richard I. Kermod Dec. 1975 40 p Sponsored in part by NSF  
(PB-253733/0; IMMR10-PD8-75; SAR-2) Avail: NTIS HC \$4.00 CSCL 07A

A flowsheet for the hydrogen production process including: all columns, tanks, heat exchangers, etc., was completed. Material and energy balances for each piece of equipment were also completed for the case of hydrogen produced at 1000 psi and a coal feed to the partial oxidizer. All equipment sizes and materials of construction, as well as the capital cost, were specified for this case. The single-stage low-temperature carbonizer operated continuously for five hours or less. Improved understanding of the variables affecting the batch flotation column operation:

centered on the temperature distribution along the length of the column and its effect on the extent of separation. Other variables studied were the amount of cresol present in the solvent oil, the inlet ash concentration, the diffuser pore size, and the pre-heating time. The trace element study progressed from tetralin solvation alone to hydrogen plus tetralin solvation. GRA

**N76-33704#** General Electric Co., Philadelphia, Pa.  
**SOLAR HEATING EXPERIMENT ON THE GROVER CLEVELAND SCHOOL, BOSTON, MASSACHUSETTS Annual Report**  
15 Jul. 1975 156 p  
(Contract E(11-1)-2626)  
(PB-253303/2; NSF/RA/N-75-272) Avail: NTIS HC \$6.75 CSCL 13A

Data obtained during the first full year's operation of an industrial solar heating system of pilot plant scale located at Grover Cleveland Middle School (Boston) are presented. Included are a brief description of the system, operational data, maintenance data, problem areas, and major conclusions drawn from the experiment. GRA

**N76-33705#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.  
**THERMIC CONTROLS TO REGULATE SOLAR HEAT FLUX INTO BUILDINGS Final Report, 1 Jul. 1975 - 31 Oct. 1976**  
Shawn Buckley 2 Apr. 1976 75 p refs  
(Grant NSF GI-43897)  
(PB-253345/3; NSF/RANN/SE/GI-43897/FR-76-3; NSF/RA-760076) Avail: NTIS HC \$4.50 CSCL 10A

Thermic diode solar panels are a new method of heating buildings using solar energy. Each panel combines all the necessary elements of a complete solar energy system (collector, controls, storage, heat exchangers and ducting) into a 4 ft x 8 ft module. The economics of thermic panels were determined using a computer simulation of a typical house under actual weather conditions for eight different climate types. The resulting heat savings over the life of the panel are compared to the panel's installed cost. Thermic panels are compared also to other typical solar heating systems such as air heating and water heating, active and passive. Since the panels can be used for cooling a building with only a simple modification, an analysis of their cooling performance is presented. GRA

**N76-33712#** Tetra Tech, Inc., Arlington, Va.  
**A PRELIMINARY ASSESSMENT OF THE TIDAL POWER POTENTIAL AT TWO SITES IN THE VICINITY OF CUTLER, MAINE**  
Bernard LeMehaute Apr. 1976 44 p  
(Contract N00014-76-C-0239)  
(AD-A023824; TETRAT-A-642-76-238) Avail: NTIS CSCL 10/2

This is a preliminary assessment of Machias Bay and Little Machias Bay near Cutler, Maine, as potential sites for a tidal power plant to provide electrical power for nearby Naval radio stations. This report contains a discussion of the power requirements and energy potential at these sites, tidal power plant systems which might be used, and economic considerations. The analysis consists primarily of a comparison with the operating tidal power plant at Rance, France. Author (GRA)

**N76-34036#** Energy Research and Development Administration, Washington, D.C. Buildings and Industry Div.  
**INTERNATIONAL ENERGY AGENCY WITH EMPHASIS ON THE SUBGROUP ON ENERGY RESEARCH AND DEVELOPMENT AND THE ENERGY CONSERVATION WORKING PARTY**  
Dec. 1975 38 p refs  
(ERDA-76-13) Avail: NTIS HC \$4.00

Activities of the Subgroup on Energy Research and Development and the Working Group on Energy Conservation are summarized. These include projects to explore the following: (1) hydrogen from water; (2) waste heat utilization; (3) municipal

and industrial waste utilization; (4) coal technology; (5) radioactive waste management; (6) nuclear safety; (7) thermonuclear fusion; (8) solar energy; and (9) energy conservation. The thermal characteristics of buildings, heat pumps, thermal storage, and heat exchangers are also studied. ERA

**N76-34050#** Battelle Pacific Northwest Labs., Richland, Wash.  
**ECONOMIC ANALYSIS OF GEOTHERMAL ENERGY COSTS**

C. H. Bloomster 1975 33 p refs Presented at 68th Ann. Meeting of Am. Inst. of Chem. Engr., Los Angeles, 16 Nov. 1975

(Contract E(45-1)-1830)

(BNWL-SA-5596; Conf-751107-17) Avail: NTIS HC \$4.00

A description is given of the computer program, GEOCOST, and its application to some analyses of the economics of geothermal energy. GEOCOST combines both technical and economic factors into one systematic cost accounting framework. The program, which simulates production of electricity from most types of geothermal resources, is composed of two parts: a reservoir model which simulates the costs associated with the exploration, development, and operation of a geothermal reservoir; and a power plant model which simulates the costs associated with the design, construction, and operation of the power plant. The costs from the reservoir model become the energy supply costs to the power plant. The combined reservoir and power plant models represent the complete energy production system.

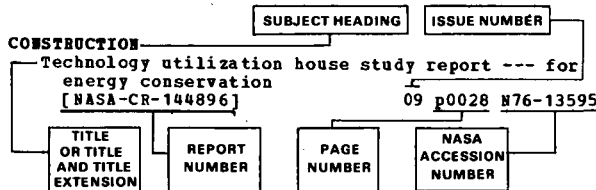
Author (ERA)

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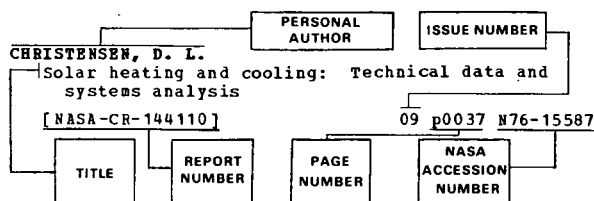
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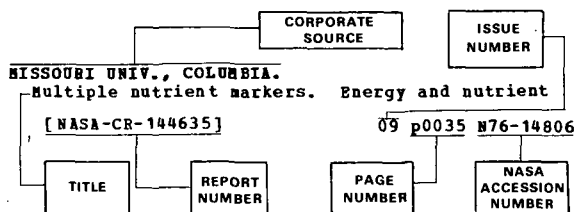
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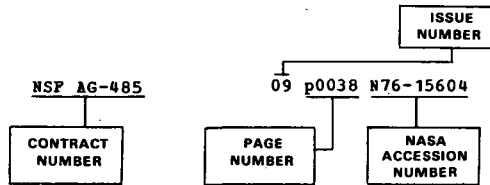


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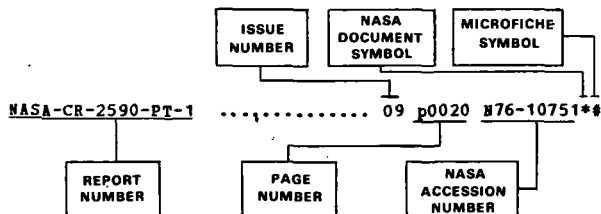
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